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THE OLDEST RAILROAD JOURNAL IN THE WORLD

AMERICAN ENGINEER AND RAILROAD JOURNAL.

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J. S. BONSALL, Vice-President and General Manager

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Editors:

E. A. AVERILL. OSCAR KUENZEL.

AUGUST, 1910

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Much has been said and written on this subject recently, both in this country and abroad, showing that there certainly is no lack of interest, especially by men prominent in engineering and railroad work, who have spent considerable time investigating many of its conditions and phases.

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AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION

FORTY-THIRD ANNUAL CONVENTION.

(CONTINUED FROM PAGE 296.)

LOCOMOTIVE AND SHOP OPERATING COSTS.

Committee: H. H. VAUGHAN, Chairman; W. C. A. HENRY, M. J. McCARTHY, LE GRAND PARISH, G. W. SEIDEL.

The committee appointed to report on the subject of Locomotive and Shop Operating Costs considered it advisable to confine themselves to one of the various classes of expenses which might be included under that description. Such costs, as a whole, are, evidently, too complicated for the purpose of a single report, comprising, as they do, those of fuel, repairs, enginehouse expenses and various other items. They will, therefore, chiefly discuss those included in the account "Repairs of Locomotives," and the method adopted in supervising the expenditures of that description.

Inquiries made of a number of the largest railroads show that the appropriation plan for determining pay-rolls is in general use. As a rule, an estimate is prepared by the divisional authorities, stating the amount they require for their pay-roll during the coming month, compared with the actual figures for the preceding month, and corresponding month in the previous year, and an explanation of the reason for any increase desired. These estimates are consolidated into a statement at headquarters, and, after any criticism or alteration has been decided on, are approved, and practically constitute an authority for the expenditure in labor called for. Generally, it is understood that such authority is not to be exceeded unless in case of emergency, and in some cases no over-expenditure is permitted without additional authority being obtained. It is evident that such a rule cannot be enforced in the case of roundhouse forces, which must necessarily be maintained, but it may be more or less closely adhered to in general repair shops. On several roads, weekly or biweekly pay-roll statements are prepared for the purpose of checking the actual expenditures against the estimates, but this practice does not appear to be usual, although, no doubt, it is carried on locally even if not recognized as part of a regular system. At the end of the month it is usual to compare the actual with the estimated pay-roll and require an explanation of any increase over the figures approved. This system appears to work successfully and enables close control to be maintained over labor expenditures without unnecessary complication, provided it is handled reasonably and firmly. While it deals with the pay-rolls as a whole, it actually limits the expenses on any one account, since the distribution will usually bear certain proportions.

The limitation of pay-rolls, while requiring in a way the exercise of economy and the production of the best results from a given amount of labor, cannot by itself be considered as a complete system. If permanently persisted in beyond certain limits, the condition of the power would deteriorate, or the number of engines requiring repairs would increase. The condition that exists is broadly that a certain amount of work is to be done and that the cost will depend on the efficiency with which it is accomplished. The peculiarity of repair work depends on both of these. In this respect, it differs from the usual run of manufacturing operations on which the work to be done is usually determined, or at any rate is not a question for constant watchfulness. In the maintenance of locomotives the amount of work required to keep them in repair per mile may vary widely, and may have a greater effect on the ultimate cost than the efficiency with which it is performed. In the case of running repairs no system appears to have been developed by which any alteration in the work required or its efficiency may be promptly detected. The piecework system in roundhouses has been used and, of course, determines the cost of doing the work. It would, consequently, also detect any increase in its quantity, but it is unfortunately not suitable in many ways for work of this nature. The thorough specification of the various operations is exceedingly complicated, and the time required to properly give out the work and check it is a serious proportion of that of doing it. While, therefore, it has been worked with a fair measure of success, it is not entirely satisfactory for roundhouse purposes. On one road a system is in effect by which all mechanical department officials are furnished daily with the labor expenses incurred on the territory under their supervision. This expense is shown in detail; that is to say, it is divided into ordinary locomotive repairs, wreck and other repairs, shop tools and machinery, manufacturing work, etc. This information is, of course, more accurate than that of the pay-roll alone, as it specifies the distribution among the various accounts. Another road is trying a system by which roundhouse foremen are notified weekly of the labor charges against running repairs on each engine handled in their terminal. In this case it is possible to watch the cost of maintaining individual engines, and the information is furnished with the idea that any cause leading to unusual expense may be more promptly brought to attention. The whole question of the proper supervision of running repairs is, however, a difficult one. The cost is about one-half of the total cost of locomotive repairs, but the number of engines involved and the variety and small cost of the majority of the operations performed make any detailed watching exceedingly complicated. The work required on any individual engine also varies considerably from day to day. It will run for a time with comparatively little expense and may then require considerable work for a period. For work of this kind, it would appear questionable whether much more can be done than to closely watch the pay-roll or distributed labor at each terminal and its relations to the business handled. When these are properly proportioned, any increase in the work required will be quickly known by the foreman in charge, who is in the best position of anyone to discover the reasons. In the case of shop repairs, it is possible to exercise considerably closer supervision. These repairs are occasional in place of being practically continuous, as running repairs, are. They can, consequently, be more carefully analyzed, and their cost compared with the service rendered. The distinction between running repairs and shop repairs varies on different roads, from a repair costing over $5 for labor to one costing $400 total. This variation is not important for the purposes of this report, although it affects to a certain extent the practice which is followed in supervising shop repairs.

Several roads require estimates to be submitted and authority obtained before shop repairs are made on an engine. In some cases this applies to all shop repairs, in others to all those over a certain amount, varying from $75 upward. The authority of an executive officer may be required for repairs over a limit which varies from $1,000 to $5,000. Notice of an engine requiring repairs may be submitted thirty days before engine is shopped, in order to enable the cost of the repairs recommended and the service of the engine being investigated. In one case, in which each class of engine is given an allowance per mile for repairs, engines may be shopped without authority if the cost of the repairs will not cause the allowance to be exceeded; otherwise, it must be obtained. When estimates are made, their correctness may be checked by comparison with the actual cost when completed, and explanation required if exceeded. There are, naturally, many variations in the details with which this work is carried out on different roads, but some system for watching the cost of shop repairs in advance is in general use. The committee would call attention to the fact that the most important question when an engine requires shop repairs, is the miles made since last repaired. While criticism of the nature of the repairs required may occasionally lead to additional mileage being obtained from an engine by the application of minor repairs, this condition is not usual, and, as a rule, the cost of the repairs can not be economically reduced by estimates made before an engine is shopped. Such estimates are difficult to make accurately, and may tend to limit the repairs to the amount allowed. Limiting repairs that are actually required to put an engine into good condition is not economy. Whatever may have been the reason, after an engine has been taken out of service and sent to the shops, the cheapest plan is to then make the repairs properly and thoroughly, so that when turned out the engine will make as many miles as possible before needing to be again shopped. The cost of shop repairs is not properly the cost per repair. It depends on the cost per mile, and the miles made between repairs are, therefore, equally as important as the cost of the repairs when made. All shop repairs are not necessarily those which put an engine into thoroughly good condition, but whatever be their nature, the question of their being justified by the mileage made is the one of greatest importance. For this purpose, information as to the miles made since last general overhauling and the nature and cost of the intermediate repairs received will show whether the class of repairs called for should be necessary or not. The introduction of an allowance per mile has the advantage of presenting the influence of large or small mileage in dollars and cents in place of miles only. Whether this is used or not, a simple statement, involving the shop repairs since last general overhauling, the mileage made and the nature of the repairs required, really gives all the information that can be advantage-

ously used in determining whether the engine has been properly maintained and used and a reasonable mileage obtained from it. If the repairs are actually needed there is little doubt that they should be thoroughly made, and to do this in the most economical way is then a problem for the shop.

The great degree of variation in the amount of work required in making locomotive shop repairs, even though they are classified as being of the same general nature, makes it almost impracticable to watch their cost as a whole. When this is done, the best system in use is that which furnishes the foreman or shop superintendent a daily or weekly statement of the labor applied on the individual engines under repair, usually divided to show that in each department separately. By this means, information is obtained while the work is in progress, which will call attention to any engine on which the labor is exceeding the expected amount. The difficulty usually experienced is that on account of one engine requiring more work than another the differences are difficult to analyze, and, if thorough analysis is attempted, the work has to be split up into a number of different operations so that the cost of each may be individually known. Where piecework or any of the various efficiency systems are in use, this is, of course, the case, but, apart from any question of rewarding labor, the cost of the individual operation appears to be the only logical basis on which the cost of locomotive repairs can be determined in the shop. It is true that much of the work done, even when divided with considerable detail, still varies to a certain extent from one engine to another, but this variation is not sufficient to prevent knowledge being obtained of what the work is costing and enable any increase being immediately known. Whatever may be the system employed, some method of watching the cost of repairs in detail enables the efficiency of a shop to be supervised in a way that is not otherwise possible. The committee does not believe it is necessary to discuss the various systems in use for this purpose. They have been fully dealt with at other times and are generally known and understood. One point may, however, be referred to. Any operation may be reduced to a series of detail operations, and the time required for those may be determined with considerable accuracy. For instance, in turning an axle, the time required to lift the piece, place it in the lathe, take the various cuts, roughing and finishing, and replace it on the floor, may all be individually recorded and thus compared with corresponding operations on other pieces or with known performances. Such records are now generally known as time studies, and their use enables the time required for numerous operations being checked from known data, in place of depending on the results obtained from the man performing the work or the judgment of the foreman in charge. Locomotive shops have the advantage that the work performed in them is repeated time after time, and, under this condition, there are few operations that do not repay time spent in making the proper study of the best method of performing them. What is, however, perhaps equally important, is the means they afford of comparing, for similar operations, the relative costs of different methods or of different types of machines. Such comparisons are evidently valuable when applied to the various repair shops on a railroad, and the committee has investigated the possibility of arranging for their exchange among some of the members of this Association. The advantages of such a course are, from one point of view, obvious. There are numerous operations which vary but little in different repair shops, and the determination of the best method or result would be far more certain if derived from the experience of the shops on several railroads than from those of one. Comparisons of total times of most operations would be misleading, on account of the differences in conditions and practice, but the same objection does not apply to properly determined time studies, as the details may be readily adjusted to allow for differences in design, conditions, etc. The opinion of those of our members who have been consulted differs as to the advisability of such exchange. Some have signified their willingness to co-operate, while others do not care to. There are, evidently, difficulties connected with the course apart from the practice on some roads of not divulging time or piecework schedules. A road giving information would naturally expect to benefit by receiving from others to a reasonably equal extent, and means by which this could be ensured are not easy to devise. The shops in which this work has been carried out are limited in number, and in many cases it is only partially completed. The committee, therefore, considers that at the present time it would be unwise to recommend any arrangement for the interchange of time studies, although it believes that in the future some benefit might be obtained if a suitable plan could be outlined.

In considering the methods used for watching the results obtained, as opposed to those that have been discussed for watching the expenditures being made, the most important statement is, of course, the performance sheet. The form in which this is made out varies considerably on different roads, and in many cases references are made to units which are evidently retained on account of the familiarity with them of those concerned. Apart from performance sheets there are, however, a number of statements in use which it will be interesting to refer to.

Most roads prepare statements showing cost of shop repairs by classes of engines and nature of repairs, in some cases these being compared with estimate made when engine was shopped. One road reports a very good method for recording the cost of shop repairs, keeping separate the cost of the following divisions of the work:

Stripping.	Remove flues.
Repair rods.	Repair flues.
Take off frame.	Replace flues.
Repair frame.	Boiler work.
Put on frame.	Driver brake and rigging.
Remove cylinders No. —.	Air pump, governor, piping, etc.
Apply cylinders No. —.	Driving boxes.
New fire box.	Steam pipes.
Front flue sheet.	Lagging.
Back flue sheet.	Jacket.
—— side sheets.	Paint engine and tender.
Flue sheet and —— side sheets.	Tank repairs.
Flue —— side and —— door.	

In this case the cost of the various items shown are charged separately, and it is evident that a far better comparison is obtained than when the cost is simply shown as a total. In another case the labor on each engine is reported by departments, such as machine shop, boiler shop, erecting shop, etc., and in this case also any tendency to increased cost can be fairly well localized. An output unit may be used based on the tractive power of the engine or its weight. The latter is stated to afford a better comparison of the cost of repairs than the number of engines turned out.

Statements are generally used showing cost of running repairs by classes on different divisions. In some cases cost of individual engines running repairs are not kept separately, but by classes of engines only. This statement would appear to be of considerable value in comparing results, as it enables a comparison to be made on engines of similar types and service. An allowance per mile is sometimes used for different classes of engines. This has already been referred to, but its use in a statement of this nature has another purpose. When an allowance per mile is used for shop and running repairs combined, the surplus accumulated by each engine may be watched, and knowledge thus obtained as to whether that engine when repaired will have performed its service at the cost per mile expected. If, however, the allowance is separated for shop and running repairs, the mileage made between shopping in itself determines whether or not the engine can receive its shop repairs without exceeding its shop repair allowance, while the performance of the engines based on their allowance for running repairs distinguishes in an easy way between those classes or divisions which are costing more or less than the average. In addition, if the allowance be based on the engine mile, the tractive power mile, or the engine ton-mile, whichever unit may be used in comparing results, such a statement shows which classes or divisions have exceeded or which have run below the allowed rate, and, therefore, enables the causes of overexpenditures to be localized to that extent.

A similar statement may also be used for shop repairs, but in that case a difficulty arises from the fact that the number of engines shopped on a road or a division does not necessarily bear any relation to the miles run. Over a considerable period the condition of the power can not vary sufficiently to make the difference important, but for one month, or, indeed, for several, shop repairs may be reduced below those required to maintain the power in a uniformly good condition or may be required in excess of the normal in order to improve it. This difficulty may be remedied by referring the cost of each engine receiving shop repairs to the mileage made by it since last repaired, and working out the cost per mile on this basis, in place of comparing the cost to the mileage run during the month. By this means, the cost for each engine or class of engines determines for those repaired during each month their cost per mile for shop repairs since their last shopping, and thus enables the expensive or economical classes to be located without respect to the number of them shopped during the month. It is thus possible to prepare a statement which shows the results of the month's shop repairs with the same accuracy as that showing those for running repairs. Evidently in such a statement the cost of the shop repairs may be made to balance with the charges against that account for the month, but the mileage, and, consequently, the cost per mile, will vary from that run by engines during the month, as it is based upon that made by the engines shopped since last repaired. Over a considerable period the mileage would correspond if no power were purchased or scrapped, but under usual conditions the mileage run exceeds that shopped, owing to that made by new and scrapped engines. The difference is not important, however, and a statement made on this basis has the advantage that the cost per mile for shop repairs is obtained with the same accuracy as that for running repairs, and without reference to the relation between the amount of shop repairs effected in any month and the mileage run during that month. When combined with an allowance per mile or other unit, it is then possible to localize the engines which exceed or are below the average cost and the amount by which they affect the result.

On several roads, while statements showing cost of individual repairs are not prepared separately, the cost per mile for

different classes of engines on different divisions is shown in the performance sheet. This can not, however, be said to be general. The performance sheet is usually arranged to show results as a whole rather than in detail, the latter being analyzed by departmental statements. For this purpose there is a tendency to introduce a unit which will afford a better comparison than the engine mile. Owing to the large variation in the size of locomotives now in service and the greater cost of maintaining them as the size increases, the cost per mile no longer compares the expense with the service rendered. The ton-mile is decidedly less accurate, since, while the cost of maintaining the same class of power does not vary greatly in level and hilly districts, the load hauled by them does, and, in fact, the engine that is working on heavy grades, while it may not haul more than one-third the load that it would on the level, costs slightly more to repair per mile run. While, therefore, the cost per ton-mile is important from an operating standpoint, its use in connection with locomotive repair costs introduces a variable which can not be affected by the efficiency with which those repairs are handled. The unit needed is one that takes into account the size and capacity of the engine and those in use are either based on its weight or its tractive power. The weight may be taken as the total weight of the engine without tender, the light weight of the engine or the weight on drivers. The latter corresponds very closely to the tractive power and appears to be the preferable unit. While the total weight of the engine represents, presumably, the power that is available for hauling trains, as it is reasonable to assume that it has been disposed of to the best advantage, whether a small tractive power was required for high speeds or a large one for low, yet, the weight on drivers or the tractive power is more closely proportioned to the cost of maintenance. In the case of two engines of equal weight, one constructed as a ten-wheeler, the other as a consolidation, the ten-wheel engine will not only cost less per mile to maintain, but will usually cost less per mile per pound of tractive power or weight on drivers. Again, when two engines of equal weight are employed, the one in freight and the other in passenger service, the cost will usually be less for the passenger engine when based on the tractive power mile, and, as the tractive power or weight on drivers usually bears a smaller proportion to the total weight on passenger engines than in freight, it is evident that if the truth of these two propositions be granted, the unit based on pound of tractive force or weight on drivers represents more accurately than one based on the total or light weight of the engine, the comparative cost of repairs. As between the two former there is little to choose, but as the tractive power represents more closely the service delivered, the committee feels that it is the preferable unit, and wishes to recommend the more general use of it. They consider that the best method is that in which the tractive power of the engine is expressed as a percentage of 100,000 pounds, so that an engine having a tractive power of 30,000 pounds is called a 30-per-cent engine, the tractive power being calculated at 85 per cent of the boiler pressure. The use of such a unit is valuable in including in the cost of maintenance a factor that varies with the increasing size and cost of power, and, consequently, presents that cost with closer reference to the service rendered.

The committee does not feel that any useful purpose would be served by a discussion of the various forms of performance sheets in use. On most roads the desire exists for figures that are comparative with those of past years and rendered useful through custom. The exact way in which these figures are presented is of less importance than the retention of familiar methods which enable them to be easily used. They have investigated the willingness of a number of roads to enter into an arrangement for exchange of performance sheets, a plan that should be mutually interesting and advantageous. The replies are not unanimous, but sufficient roads have stated that they would be willing to do this to make the proposition worth recommending. The variations that previously existed in the classification of accounts have now been done away with, so that this objection to the interchange of information no longer exists. While, no doubt, conditions vary widely on different roads, yet, the consolidation of railways into large systems has led to comparisons between roads in one system which vary just as much from one another as do those which are entirely separate. Mutual exchange of results should, therefore, prove of considerable advantage to those of our members who care to enter into an arrangement for this end. The Master Mechanics' Association could be of use in this matter, by ascertaining which roads would be willing to exchange results and furnishing mailing-lists, or preferably printed addresses, so that the work of sending out the information would be facilitated. It does not appear advisable to exchange performance sheets as a whole. They usually contain a good deal of information that is not of value except to the officers of the road for which they are prepared, and the committee herewith submits the following form, which they would suggest as meeting the requirements for furnishing such results as would be valuable and interesting to exchange.

NAME OF ROAD.

Month of ...., 191..

ITEMS.

Number of locomotives.
Average haulage capacity, per cent.
Total locomotive mileage.
Total gross ton-mileage.
Per cent of locomotives in service.
Per cent of locomotives under and waiting repairs (shop).
Per cent of locomotives under and waiting running repairs.
Repairs per locomotive-mile, total.
Repairs per locomotive-mile, shop.
Repairs per locomotive-mile, running.
Fuel, pounds per locomotive-mile, passenger.
Fuel, pounds per locomotive-mile, freight.
Fuel, pounds per locomotive-mile, all classes.
Fuel, pounds per 1,000 ton-miles, passenger.
Fuel, pounds per 1,000 ton-miles, freight.
Fuel, pounds per 1,000 ton-miles, all classes.
Lubricants, cost per locomotive-mile.
Lubricants, cost per locomotive-mile per 100 per cent capacity.
Other supplies, cost per locomotive-mile.
Other supplies, cost per locomotive-mile per 100 per cent capacity.
Enginehouse expenses, cost per locomotive-mile.
Enginehouse expenses, cost per locomotive-mile per 100 per cent capacity.

NOTES.—Haulage capacity per cent equals tractive power at 85 per cent of the boiler pressure divided by 1,000, *i. e.*, an engine of 100 per cent capacity is one having a tractive power of 100,000 pounds.

Results per mile per 100 per cent capacity are based on mileage of each engine or class of engines multiplied by its capacity.

State distinction between shop and running repairs..........

This excellent report was not read on the floor of the convention because of the absence of any member of the committee and therefore was not given any discussion.

SIZE AND CAPACITY OF SAFETY VALVES FOR USE ON LOCOMOTIVE BOILERS.

Committee:—F. M. Gilbert, James Milliken, W. D. Robb, M. H. Wickhorst, J. G. Neuffer.

The remarks and suggestions below will relate to locomotive boilers only. Further, they relate only to locomotive boilers using coal as the fuel, and under the conditions now prevailing for the stimulation of the draft by the use of exhaust steam from cylinders of the locomotive and by means of the ordinary steam blower.

A series of tests were made for the committee by Mr. E. D. Nelson, Engineer of Tests, of the Pennsylvania Railroad, to determine the maximum or worst condition that the safety valves were required to take care of. With the gauge pressures of 190 to 207 pounds, it was found that the maximum discharge of steam was 2.44 pounds, the minimum 1.18 and the mean 2.05 pounds per square foot of heating surface per hour.

The committee has taken twice this mean value as the basis for a formula, which, in their opinion, will reduce safety-valve practice to a uniform basis, and at the same time provide proper relief for the boilers. Such a formula may be expressed as follows:

$$A = \frac{0.08 H.S.}{P}$$

A = Outlet of valve in square inches.
H.S. = Boiler heating surface in square feet.
P = Absolute pressure = gauge pressure + 15 pounds

This formula will provide, on boilers carrying 200 pounds gauge pressure, an outlet that will take care of 4.1 pounds of water per square foot of heating surface per hour.

A number of observations were made on locomotives in passenger service, provided with safety valves, the combined outlets of which would take care of from 3.64 to 4.06 pounds of steam per square foot of heating surface per hour, and no cases were found where the safety valves failed to properly relieve the boilers. The locomotives on which investigations were made carried 200 pounds gauge pressure, had 4,231 square feet of heating surface and 56½ square feet of grate area.

Past investigations have verified that Napier's rule for the flow of steam may be safely taken for the types of muffled safety valves now on the market.

It is, perhaps, superfluous to state that, having assigned proper values for safety valves, means should be provided for maintaining those values. In other words, the maintenance of proper areas of outlet should be a feature of safety-valve maintenance and repair.

For the guidance of the designer, the valve manufacturers' lists should show nominal size of valve, the outlet in square inches, under various pressures, and the capacity for discharge

of steam in pounds under the various pressures. For the guidance of the repair man, the lifts of valves under the various pressures should also be shown.

In the discussion it was objected that the committee had not specified the lift of the valve in determining the area of the opening and that the method of determining this area should be more clearly specified.

Upon request of one of the members, Mr. Gilbert stated that it was the custom on the New York Central on locomotives having two safety valves to set one at 2 lbs. pressure above the other and in cases where there were three safety valves the third one is set at 3 lbs. higher pressure than the second or 5 lbs. higher than the first.

Upon motion the report of the committee was accepted.

SUPERHEATERS.

In 1901, the Canadian Pacific Ry., under the pioneer leadership of Mr. Roger Atkinson, of the Canadian Locomotive Works, introduced the use of superheated steam on locomotives in America. A few years later Mr. H. H. Vaughan extended the use, and the success of the superheater is due in a great measure to his push and energy. To-day we have reports from twenty American roads which have more or less engines equipped.

The circulars asked for answers based on comparative tests made as to certain particulars. However, the circulars requested that the data as to costs, etc., for superheater and non-superheater locomotives be taken from regular service records covering a considerable period of time.

Railroads answering having superheaters: American, 20; foreign, 2.

Superheaters on American roads reported as follows:

A., T. & S. F.	168
Boston & Maine	1
C. & N. W.	1
Canadian Pacific	487
C., B. & Q.	5
Central of Georgia	1
C., R. I. & P.	9
Erie	1
Great Northern	61
M., St. P. & S. S. M.	1
National Ry's. of Mexico	1
Northern Pacific	36
N. Y. Cent. (L. S. & M. S.)	2
Oregon Short Line	2
Pennsylvania	1
Pittsburg, Shawmut & Northern	1
Southern Pacific	2
St. L. & S. F.	21
W. & L. E.	1
Union Pacific	3
Total	805

Railroads answering, but not having superheaters: American, 34; foreign, 9.

Superheaters which are considered and number of engines reported, as follows:

Types of Superheaters.	Number of Railroads.	Number of Engines.
Baldwin	12	79
Churchward (England)	1	61
Cole	6	13
Emerson	2	59
Jacobs	1	104
*Schmidt	3	58
Union Pacific	1	1
Vaughan-Horsey	5	491

* Schmidt superheaters are used on 130 railroads in Europe, and in service, or in course of construction, on over five thousand locomotives.

[*The report contains illustrations and brief descriptions of the various types of superheaters, all of which have been given in this journal except the Union Pacific type, which is given below.*—Ed.]

UNION PACIFIC SUPERHEATER.

The Union Pacific superheater (see illustration) is of the smoke-box type, and in effect is the usual steam pipe transformed into a superheater by increasing the area and splitting it up into a number of small tubes.

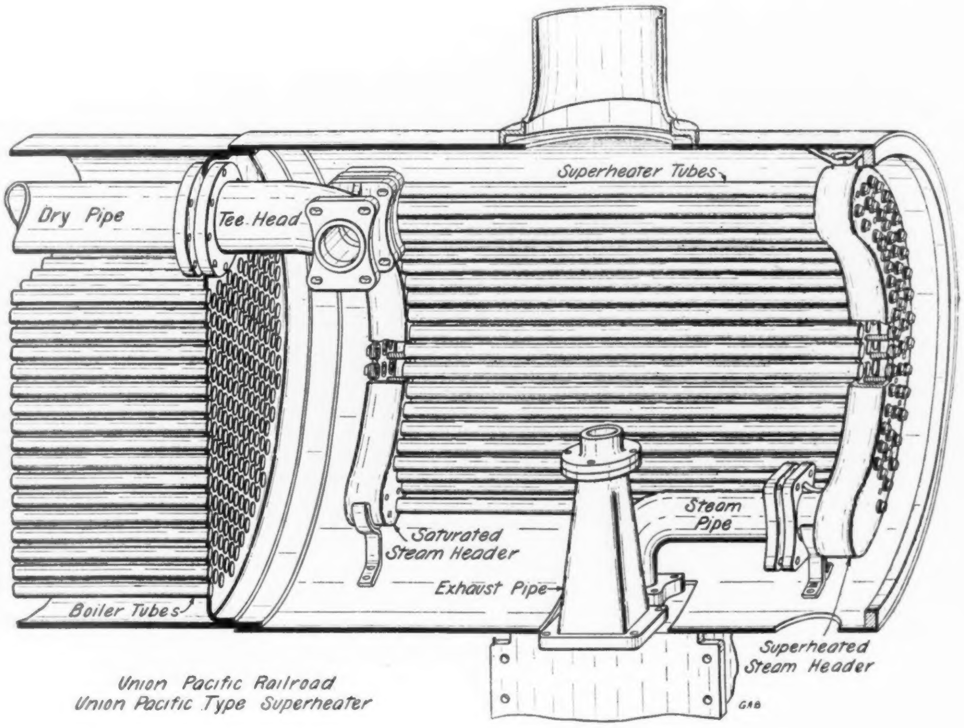
The steam pipe forms vertical headers of a crescent shape at the front and rear of the smoke box, and between them are placed 108 2-inch tubes, arranged horizontally. The ends of the tubes are fastened to the headers by the usual method of expanding with a roller, the roller being inserted in a hole in the header opposite the tube, which is afterwards closed with a screw plug.

The steam passes into the top of the rear headers, thence forward through the tubes to the front headers, thence downward to steam-pipe connection to the steam chest.

The more important items of running repairs, valve oil and coal, are arranged in tabular form, and the per cent. of saving or increased cost of the superheater is given, as follows:

COST OF RUNNING REPAIRS PER 100 TON-MILES OR PER PASSENGER CAR MILE

Road.	Superheater.	Non-Superheater.	Per Cent. Saving of Superheater Over Non-Superheater.	Per Cent. Increased Cost of Superheater Over Non-Superheater.
	Baldwin Superheater			
A., T. & S. F.	Comparisons not available, as superheater and non-superheater engines do not run on same district.			
Central of Georgia	.038	.046	17.4	....
C., B. & Q.	.018	.026	30.8	....
	.024	.026	7.7	....
Oregon Short Line	.0234	.0225	...	4.0
Southern Pacific	.059	.050	...	18.0
	Cole Superheater.			
Boston & Maine (Pass.)	.0725	.0641	...	13.1
Wheeling & Lake Erie	.0366	.0342	...	7.0
	Jacobs Superheater.			
A., T. & S. F.	.124	.161	23.0	....
	Schmidt Superheater.			
C., B. & Q.	.031	.027	...	14.8
	.030	027	...	11.1
Great Northern (Pass.)	.0403	.0807	50.0	....
	.193	.092	...	110.0
	Vaughan-Horsey Superheater.			
Canadian Pacific (Freight)	.024	.0408	41.1	....
	.0415	.0477	13.0	....
Canadian Pacific (Pass.)	.0306	.0376	18.6	....
	.0290	.0287	...	1.0
C., B. & Q.	.0150	.0270	44.5	....



Union Pacific Railroad
Union Pacific Type Superheater

COST OF VALVE OIL PER MILE

Road.	Superheater.	Non. Superheater.	Per Cent. Saving of Superheater Over Non-Superheater.	Per Cent. Increased Cost of Superheater Over Non-Superheater.
	Baldwin Superheater.			
Oregon Short Line	.00123	.00103	...	19.0
Southern Pacific	.00137	.00118	...	16.0
	Cole Superheater.			
Wheeling & Lake Erie	.00118	.00059	...	100.0
	Schmidt Superheater.			
Great Northern (Pass.)	.00175	.00137	...	27.7
	.00254	.00132	...	92.5
	Vaughan-Horsey Superheater.			
Canadian Pacific (Freight)	.0110	.0077	...	43.0
	.0074	.0061	...	21.3
Canadian Pacific (Pass.)	.0067	.0069	2.9	....
	.1162	.0064	3.1	....

COST OF COAL PER 100 TON-MILE OR PER PASSENGER CAR MILE

Road.	Superheater.	Non. Superheater.	Per Cent. Saving of Superheater Over Non-Superheater.	Per Cent. Increased Cost of Superheater Over Non-Superheater.
BALDWIN SUPERHEATER.				
C., B. & Q.	.0114	.0122	6.5	....
	.0106	.0122	13.1	....
Oregon Short Line	.200	.230	13.0	....
Southern Pacific	.0135	.0135	...	....
COLE SUPERHEATER.				
Wheeling & Lake Erie	.0169	.0191	11.5	....
JACOBS SUPERHEATER.				
A., T. & S. F.	.0116	.0170	31.8	....
SCHMIDT SUPERHEATER.				
C., B. & Q.	.0105	.0130	19.2	....
	.0109	.0133	18.0	....
Great Northern (Pass.)	.0195	.0208	6.2	....
	.0207	.0248	16.5	....
VAUGHAN-HORSEY SUPERHEATER.				
Canadian Pacific (Freight)	.148	.153	3.3	....
	.219	.298	26.5	....
Canadian Pacific (Pass.)	.0115	.0199	42.2	....
	.0187	.0194	3.6	....
C., B. & Q.	.0098	.0120	18.3	....

TROUBLES REPORTED IN REPLY TO CIRCULAR LETTER.

BALDWIN SUPERHEATER.

A. T. & S. F.—Some trouble with steam-pipe joints leaking; front end fills up.

C. B. & Q.—No trouble.

Central of Georgia.—No. This engine has record of not having a single failure in making 30,595 miles.

Erie.—Front end fills up with cinders. Cinders also ruptured several superheater pipes so they had to be plugged.

Nat'l. Rys. of Mexico.—Front ends fills up with cinders. No remedy at present—experimenting.

Oregon Short Line.—No trouble. Twelve months' service.

Pennsylvania.—No trouble.

Pittsburg, Shawmut & Nor.—Front end fills up.

Rock Island.—Cinders cut superheater tubes due to sand-blast action. Front end filled up with cinders and engine does not make steam.

Southern Pacific.—No trouble.

Union Pacific.—No data.

COLE SUPERHEATER.

C. & N. W.—Very little.

Boston & Maine.—Superheater flues at firebox end expanded and beaded instead of screwed. Gaskets leaked between headers and T-head; improved design has obviated this trouble. Superheater flues have given trouble by filling up; blower applied and works well. Other small defects, for instance, leaks at junction of the superheater pipes and return bends ascribed to defects of material rather than of design.

New York Central.—A little trouble in roundhouse on account of keeping joints tight; not serious, however.

Northern Pacific.—Cinders in passing through tubes wear out return bends. Gaskets at connection between small superheater pipes and main header give same trouble.

Rock Island.—Had trouble with Field tubes stopping up. Changed to return-tube system and had no trouble. Had trouble with joints and fastenings. Recent designs obviate this trouble.

Wheeling & Lake Erie.—No.

EMERSON SUPERHEATER.

Great Northern.—Threaded pipes in return bends break off. Now welding pipe into the return bend.

JACOBS SUPERHEATER.

A. T. & S. F.—Occasional leaks in steam-pipe joints. Recent designs have joints on the outside.

SCHMIDT SUPERHEATER.

C. B. & Q.—Leaks in front end overcome by providing more secure fastening for the blocks connecting superheater pipes to the header and by bracing the header to smoke arch. Clinkers formed on back end of superheater pipes; cleaned off every trip.

European Railways.—So far as we know, neither the superheater itself nor the large smoke tubes have given any trouble in European practice. In a few isolated cases, the large smoke tubes have begun to leak at the fire-box side; in such cases, investigation has shown that the tubes were not properly expanded in the tube sheets, nor according to our recommendations. These defects have been easily remedied, after which no further difficulty was experienced. No difficulty has been experienced in European practice in keeping the joints of the superheater elements tight. An essential requirement, however, is that the bottom facing of the collector casting shall be properly machined and that the right kind of copper-asbestos gaskets shall be used for these joints; and, further, that the bolts shall be taken up after the engine has been for the first time under steam. In most cases the large smoke tubes have to be blown out every day to avoid clogging. But there are railroads, as for instance the Belgian State Railways, which blow the tubes out only every three days on the average. This largely depends upon the kind of fuel used.

Great Northern.—Yes. Gaskets leak, also threaded pipes in return bend break off. Now welding the pipe into return bend.

Northern Pacific.—Cinders wear out return bends. Gaskets at connection between small superheater pipes and main header give same trouble.

UNION PACIFIC SUPERHEATER.

Union Pacific.—No.

VAUGHAN-HORSEY SUPERHEATER.

Canadian Pacific.—Originally gave trouble, due to unsuitable gaskets between superheater pipe and header fittings. Since remedied by using stronger style of gaskets. Nuts connecting pipes to fittings originally made of brass, found to corrode, were replaced by cast steel, and later by drop-forged nuts, which has overcome the trouble. Nuts slacked off remedied by using special nutlocks and by making closer fit of the threads. Cast-iron headers cracked, caused by faulty construction; has been remedied by improved design. The tubes blocked at the return bends; has been overcome by systematic inspection and using proper appliances for cleaning and blowing out tubes.

C. B. & Q.—No more trouble than other engines.

New York Central.—Practically no trouble. Old design of holder broke once or twice, but new design gives no trouble.

Northern Pacific.—Cinders in passing through tubes wear out the return bends. Gaskets at connection between small superheater pipes and main connection give same trouble.

Union Pacific.—No trouble.

REDUCTION OF BOILER PRESSURE.

The answers show that the general practice is to reduce the boiler pressure when superheater is applied; at the same time, where there is a considerable reduction made, the diameter of the steam cylinders is increased. On the A. T. & S. F., tandem compound engines have had the high-pressure cylinder removed when superheater was applied, and the boiler pressure reduced from 220 to 160 pounds.

Where reduction of boiler pressure is made the general result shows a reduction of boiler repairs.

LUBRICATION OF SLIDE-VALVE ENGINES.

With the Baldwin superheater, four roads report slide valves on superheater engines as having no trouble in lubricating with superheat from 11 to 44 degrees.

With the Schmidt superheater, Dr. Schmidt reports European practice: "Slide valves have been tried in a few instances on superheated-steam locomotives and to our knowledge they could be worked with a fair measure of satisfaction up to a steam temperature of about 450° F. The trouble experienced with higher degrees of superheated steam on slide-valve engines is due, in our opinion, not so much to the difficulty of lubrication as to valve warping at higher temperature and seizing on its flat seat."

With the Vaughan-Horsey superheater the Canadian Pacific reports that it is impossible to lubricate slide valves above 190 degrees superheat. A heavier valve oil is used on superheater engines than on non-superheater engines.

The Union Pacific has one slide-valve engine equipped with Vaughan-Horsey superheater, and has had trouble in lubricating with a superheat of from 160 degrees to 219 degrees.

LUBRICATION.

Forced lubrication is found to be unnecessary with low and moderate degrees of superheat. Different kinds of pumps have been used on some roads when first installing superheaters and later on abandoned for the ordinary sight-feed lubricator. Of course, it is natural that superheater engines should show a little increase in the cost of cylinder lubrication over the non-superheater, but you can buy several pints of valve oil for the price of a ton of coal. In Europe, where a high degree of superheat is the practice, it is found that forced lubrication is necessary.

PISTON AND VALVE RINGS.

The result from the majority of railroads indicates that it is unnecessary to use a special mixture in casting piston and valve rings.

The New York Central, with the Cole and Vaughan-Horsey superheaters, uses a mixture containing more copper.

The Canadian Pacific, with the Vaughan-Horsey superheater, reports "had difficulty at first; have made progress and are still experimenting."

The St. Louis & San Francisco report that they recently received twenty Pacific-type engines with the Emerson superheat-

er. The cylinder packing that came with these engines gave out in about 1,500 miles. They are now using a special metal

The Union Pacific, with Vaughan-Horsey superheater on a slide-valve engine, found it necessary to apply a bronze false valve seat.

The Canadian Pacific gave results as to life of cylinder and valve packing rings for the year ending October, 1909. In freight service, packing rings on engines without superheater ran from two to three times as long as the rings on the superheater engines. In passenger service the difference was not so great. In one case the life was the same, while in another case the life of rings on the non-superheater engines was nearly double that of the superheater engines.

SUPERHEATED STEAM ON COMPOUND ENGINES.

The Jacobs superheater on the Santa Fe is the only superheater reported which superheats the steam between the high and low pressure cylinders on compound engines. These superheaters are now in service on tandem, balanced and Mallet compounds. Tests on this road prove that greater efficiency can be obtained from a superheater giving superheat between the high and low pressure cylinders, than from superheater giving superheat to high-pressure cylinders only.

DAMPERS.

The Baldwin, Emerson, Union Pacific and Jacobs superheaters have no dampers and experience no trouble from pipes burning out.

The Cole, Schmidt and Vaughan-Horsev superheaters have dampers on all roads reported, except the Great Northern (Schmidt superheater), where the damper interfered with the drafting and was taken out. The dampers are automatic in action, opening and closing as the throttle is opened or closed. They experienced no trouble from pipes burning out.

DO BOILER TUBES ON ENGINES EQUIPPED WITH SUPERHEATERS GIVE TROUBLE?

All reports show that boiler tubes on engines equipped with superheater give no more trouble than engines not equipped with superheater.

PACKING ON PISTON AND VALVE RODS.

The roads using Baldwin and Jacobs superheaters report that it is not necessary to use any special kind of packing on piston and valve rods.

The New York Central (Cole superheater) reports a packing used with a higher melting point.

The Great Northern (Emerson and Schmidt superheaters) use a special metal for rod packing when the temperature in the steam chest is above 600 degrees.

The Canadian Pacific and New York Central (Vaughan-Horsey superheater) use a special kind of packing on outside admission valves.

BOILER REPAIRS.

The Canadian Pacific (Vaughan-Horsey superheater) was the only road from which were received figures showing cost of boiler repairs.

Class of Engine.	Cost Per Engine-mile. Superheater.	Non-Superheater.
4-6-0 — D 6	.19 cents	.91 cents
2-8-0 — M 4	.33 cents	.30 cents
4-6-0 — E 5	.65 cents	.46 cents
4-6-0 — E 5	.47 cents	.31 cents

TESTS.

Tests have been made on the Central of Georgia with Baldwin superheater; Santa Fe, with the Jacobs superheater; Southern Pacific, with the Baldwin superheater; Union Pacific, with Vaughan-Horsey and Union Pacific superheaters; Northern Pacific, with Cole, Schmidt and Vaughan-Horsey superheaters, and are presented in somewhat condensed form.

CENTRAL OF GEORGIA RAILWAY CO.

Engine Test—Southwestern Division Freight Service, July, 1909. Same fifteen carloads of coal hauled in each test; same engineer and fireman each test.

Average or Total for Two Trips.	Engine 1224. Baldwin Superheater. 2-8-0 Type. Cylinders, 22 by 28 in. Weight on Drivers, 143,290 lbs. Boiler Pressure, 160 lbs.	Engine 1222. 2-8-0 Type. Cylinders, 22 by 28 in. Weight on Drivers, 143,290 lbs. Boiler Pressure, 200 lbs.
Time on road	6 hrs. 45 mins.	6 hrs. 48 mins.
Ton-miles	205,740	205,740
Total coal consumed, pounds	24,200	23,700
Coal per 100 ton-miles	11.8	11.5
Total water consumed, lbs.	168,866	166,100
Water per pound of coal	6.98	7.01
Miles run to one ton of coal	16.5	16.9

The results from the Baldwin superheater on the Central of Georgia show no advantage of the superheater engine over the non-superheater engine.

ATCHISON, TOPEKA & SANTA FE RY.

Test of Jacobs High and Low Pressure Superheater on Tandem Compound Engine versus Same Class of Engine without Superheater.*

	Engine 901. 2-10-2 Type. Jacobs Superheater. Cylinders, 19 and 32 by 32 in. Weight on Drivers, 234,600 lbs. Superheating Surface, 1,868 sq. ft. Boiler Pressure, 220 lbs.	Engine 923. 2-10-2 Type. Nonsuperheater. Cylinders, 19 and 32 by 32 in. Weight on Drivers, 234,600 lbs. Boiler Pressure, 220 lbs.
Speed, miles per hour	14.05	13.03
Tonnage	1,332	1,221
Lbs. of coal per 100 ton-miles	24.4	30.4
Saving in coal	19.6%	
Dry coal per I. H. P. hour	3.43	4.10
Decrease per I. H. P. hour	16.3%	
Equiv. evaporation of water	8.10	7.81
Saving in water	3.7%	
Superheat:		
High pressure	19.3° average	
Low pressure	95.0° average	

The superheat in high-pressure superheater averaged 19.3 degrees and in low-pressure superheater averaged 95 degrees. The relative performance of superheated engine over non-superheated engine is as follows:

Equivalent evaporation per pound of coal	3.7% gain
Coal per 100 ton-miles	19.6% gain.
Coal per I. H. P. hour	16.3% gain

SOUTHERN PACIFIC RY.

The Southern Pacific has made a test of the Baldwin superheater versus a similar engine without superheater. The superheat averaged 23.2 degrees. The relative performance of superheated engine over non-superheated engine is as follows:

Equivalent evaporation per pound of fuel	3.37% loss
Ton-miles per pound of fuel	1.35% loss
Ton-miles per gallon of water	3.32% gain

UNION PACIFIC RY.

The Union Pacific test of the Vaughan-Horsey superheater shows the superheat obtained at varying conditions of speed and cut-off. The maximum superheat is 219 degrees, with an average superheat of 185 degrees.

The Union Pacific test of the Union Pacific type of superheater shows the superheat obtained at varying conditions of speed and cut-off. The maximum superheat is 61.9 degrees, with an average superheat of 48.6 degrees.

The tests on the Northern Pacific give the following results from the Cole, Schmidt and Vaughan-Horsey superheaters:

NORTHERN PACIFIC RY.

Test of Cole Superheater versus Same Class of Engine without Superheater.

	Engine 2137. Cole Superheater. Cylinders, 22 by 26 in. Weight on Drivers, 146,300 lbs. Superheating Surface, 341 sq. ft. Boiler Pressure, 200 lbs.	Engine 2136. Nonsuperheater. Cylinders, 22 by 26 in. Weight on Drivers, 146,300 lbs. Boiler Pressure, 200 lbs.
Speed, miles per hour	30.26	28.56
Tonnage	556	599
Pounds coal per 100 ton-miles	16.2	20.6
Decrease	21.4%	
Coal per draw-bar H.-P. hour	4.91	6.54
Decrease	25.0%	
Equiv. evaporation of water	10.06	9.94
Saving in water	1.2%	
Superheat	147°	

The relative performance of superheated engine over non-superheated engine is as follows:

Superheat (average)	147 degrees
Equivalent evaporation	1.2% gain
Coal per draw-bar horse-power	25.0% gain
Coal per 100 ton-miles	21.4% gain

NORTHERN PACIFIC RY.

Test of Schmidt Superheater versus Same Class of Engine without Superheater.

	Engine 2137. Schmidt Superheater. Cylinders, 21 by 28 in. Weight on Drivers, 153,504 lbs. Superheating Surface, 248 sq. ft. Boiler Pressure, 200 lbs.	Engine 2136. Cylinders, 21 by 28 in. Weight on Drivers, 153,500 lbs. Boiler Pressure, 200 lbs.
Speed, miles per hour	15.74	15.00
Tonnage	2,437	2,429
Pounds coal per 100 ton-miles	4.98	5.92
Decrease	15.8%	
Coal per draw-bar H.-P. hour	4.55	5.64
Decrease	19.3%	
Equiv. evaporation of water	9.04	9.13
Saving in water		1.0%
Superheat	147°	

The relative performance of superheated engine over non-superheated engine is as folows:

Equivalent evaporation	1.0% loss
Coal per draw-bar horse-power	19.3% gain
Coal per 100 ton-miles	15.8% gain
Superheat (average)	147 degrees

*For full report of test see AMERICAN ENGINEER, June, 1910, page 233.

NORTHERN PACIFIC RY.

Test of Vaughan-Horsey Superheater versus Same Class of Engine without Superheater.

	Engine 1609. Vaughan-Horsey Superheater. Cylinders, 24 by 30 in. Weight on Drivers, 261,500 lbs. Superheating Surface, 326 sq. ft. Boiler Pressure, 200 lbs.	Engine 1561. Cylinders, 24 by 30 in. Weight on Drivers, 261,500 lbs. Boiler Pressure, 200 lbs.
Speed, miles per hour	10.50	11.77
Tonnage	2,073	2,034
Pounds coal per 100 ton-miles	13.1	16.2
Decrease	19.1%	
Coal per draw-bar H.-P. hour	5.41	6.54
Decrease	17.3%	
Equiv. evaporation of water.	6.87	6.87
Saving in water	—	—
Superheat	121°	

The relative performance of superheated engine over non-superheated engine is as follows:

Equivalent evaporation	Equal
Coal per draw-bar horse-power	17.3% gain
Coal per 100 ton-miles	19.1% gain
Superheat (average)	121 degrees

RECOMMENDATIONS.

The experiences gained by various railroads with superheated steam, which have been reported to the committee, indicate that the use of superheated steam on locomotives is both economical and practical. Many types of superheaters with varying degrees of superheat have been used to advantage in railroad service. In the United States there are about 60,000 locomotives, and from reports received there are 317 locomotives equipped with superheaters, or approximately five-tenths of one per cent.

This is such a small proportion that it is evident that the use of superheaters is as yet in its infancy in this country.

With this in view, the committee feels that recommendations as to type of superheater or degree of superheat are not warranted at this time.

The committee feels that this is a most important subject, and one that is worthy of much more time and consideration.

The unanimous opinion of motive power and transportation officials is that the superheater engine gets its load over the division in far better form and in better time than the non-superheater, or, as one superintendent of motive power put it, "'Tis a more snappy machine all around."

Committee:—Lacey R. Johnson, Chairman; F. F. Gaines, R. D. Hawkins, H. W. Jacobs, W. J. Tollerton.

Upon request of Mr. Vaughan, Mr. Hoffman, of the Schmidt Superheating Company of London, was granted the privilege of the floor. Mr. Hoffman spoke in part as follows:—

Of all the data furnished by the committee, the figures given with relation to the saving in coal obtained by the various superheaters will probably be of the most interest to you. With the exception of a few railways, which have used superheaters for very low degrees of superheat all railways report a pronounced saving of coal, amounting to about 20 per cent on the average for simple engines.

Only one railway, the Atchison, Topeka and Santa Fe, has made experiments with the application of superheaters to compound locomotives. The coal saving in their case is stated to have been more than 30 per cent. This is, of course, an exceptionally high figure, especially if the moderate degree of superheat obtained with this particular type of superheater is taken into account. I believe the superheat amounted to only 20 or 30 degrees on the high-pressure side and to about 100 degrees Fahr. on the low-pressure side. In European practice, using superheaters which superheat the steam to more than 200 degrees, the best coal economy so far obtained by the application of a high degree of superheat to compound engines has been between 15 and 20 per cent. The high figure on coal saving given for the Santa Fe test above referred to is probably owing to the special conditions under which those particular engines were tested and are probably only the result of a test of short duration. In the *American Engineer and Railroad Journal* of June, 1910, I find a complete report of the tests with this particular engine and it is stated that the decrease in coal consumption averages *20.8 per cent* for upgrade runs and 11.5 per cent for downgrade runs; this would give an average of about 16 per cent. This would be more within the limits of the coal savings obtained with European compound engines.

I find a further note in the committee's report concerning the application of superheated steam to compound engines, which says: "That the tests on the Santa Fe prove that greater efficiency can be obtained from superheaters giving superheat between the high and low-pressure cylinders, than from superheaters giving superheat to high-pressure cylinders only."

The above note probably refers only to low degree superheaters; in such case the result claimed would be quite natural. Taking for example the steam pressure on the high-pressure side at 220 lbs. per sq. in. and on the low-pressure side at 60 lbs. per sq. in., the temperature of the high-pressure steam would be about 395 degrees, whereas the temperature of the low-pressure steam would only be 307 degrees. A superheater in the case referred to, which is only able to superheat the high-pressure steam 20 degrees, could probably superheat the low-pressure side more than 100 degrees and would therefore be of greater advantage on the low-pressure side. But if a high degree superheater is applied, able to superheat the high-pressure steam, say 200 degrees, then it is better to superheat the high-pressure steam only, in order to get and maintain dry steam in both cylinders, the high-pressure side as well as the low-pressure side, whereas in the arrangement recommended by the Santa Fe the losses through condensation in the high-pressure cylinders are not abolished. Receiver-superheaters have the further disadvantage, that they must provide for a much bigger volume of steam to be superheated than a high-pressure superheater. The steam section in receiver-superheaters must therefore be much bigger, or else wire drawing of the steam in the receiver takes place. These are the principal reasons why, in about 500 compound locomotives equipped with the Schmidt superheater in Europe, only the high-pressure steam is superheated.

Regarding the degree of superheat, the committee did not make any recommendations. In this connection I refer you to the paper on "Locomotive Performances Under Different Degrees of Superheated Steam," showing the amounts of coal used per horse power hour for different degrees of superheat. The curves show clearly that the steam and coal consumption diminishes as the superheat increases, and that there is very little economy obtained with low degrees of superheat, or as Prof. Benjamin puts it in his paper: "The first 80 or 100 degrees of superheat does not make the same proportional decrease in the coal consumption as do the second 80 or 100 degrees increase."

I have here an official report of the Belgian State Railways, a road which has about 400 Schmidt superheaters in service, and which has had experience with Schmidt superheaters extending over 5 or 6 years. It is officially stated that practically no coal saving has been obtained with low degrees of superheat, i. e., with only 60 or 70 degrees. Mr. Schmidt has been advocating high degrees of superheat for the past 20 years; many scientific researches bearing on this question have been made and the same conclusion drawn. There are now nearly 6,000 Schmidt superheater locomotives in service or in course of construction in Europe, all of them using high degrees of superheat. In Europe we have gone through a development similar to that which I believe you are going through now. When superheat on locomotives first came up, many experts believed that it was quite sufficient to get only dry steam in the cylinders. Later on it was believed that the steam would be superheated sufficiently high to remain dry during the cut-off, and now experts are glad if they have still some superheat in the exhaust steam.

Comparatively little heat is required to superheat the steam to a high degree. If we take for instance steam of 200 lbs. pressure, about 1,200 heat-units would be required to generate dry steam of this pressure. Taking the specific heat of superheated steam of 0.6, it would require an additional 30 heat-units to superheat to 50 degrees and 120 heat-units to superheat to 200 degrees. In other words, there is required only about 7 per cent more heat-units to generate highly superheated steam of 580 degrees Fahr. than is required to generate a low degree of superheated steam of only 430 degrees Fahr. Thus the additional heat expended in order to highly superheat the steam does not amount to anything compared with the greater advantage gained by the higher degree of superheat.

The most important point in the whole superheater question is the increase in power obtained by the application of a superheater. This item is not mentioned in the different comparison sheets of the report, but it is touched upon in the final conclusions, which state that "The superheater engine gets its load over the division in far better form and in better time than the non-superheater engine." Giving you a conservative figure obtained in many years' service with thousands of Schmidt superheaters, we can say that the increase in power obtained with a high degree superheater is between 20 and 30 per cent. In other words, one ton of iron in a well-proportioned superheater engine gives 20 per cent more power than a ton of iron in a saturated steam engine. That is the principal reason why superheating has come into so much favor on European roads, and I believe it will prove the principal reason for the general introduction of superheated steam on locomotives in this country.

F. J. Cole presented the following discussion:—

"Superheating for locomotives has passed the experimental stage, and from figures contained in this report and other sources it can be demonstrated that the repairs and maintenance of the apparatus are very slightly, if at all, in excess of an engine using saturated steam. Because the demand for steam on the boiler to perform a certain amount of work is less when superheated steam is used, the boiler repairs, especially in combination with the low steam pressure commonly used on superheater engines, will more than offset any slight additional charge for the maintenance of the superheater apparatus.

The conclusions of the committee are of considerable interest, especially the statement that "superheater engines get their load over the division in far better form and in better time than the non-superheater, and are a more snappy machine all around."

While it is a fact that the number of superheater locomotives running in the United States is very small in proportion to the total number, it is interesting to remember that one or two years ago where probably only one engine in a lot would be built with a superheater, it is now a very common thing to build 20 to 25 or more engines in one lot all equipped with superheaters.

The number of different types of superheaters built by the American Locomotive Company in service or under contract is as follows:

Vaughan-Horsey		215
Cole (old)	103	
" (new)	130	233
Schmidt		73
Emerson		5
Special		2
Total		528

One of the most important possibilities of locomotives equipped with superheaters has not received the attention it justly deserves; namely, the increased hauling capacity and the greater efficiency which can be obtained than from locomotives using saturated steam. There is no doubt that this is the most important feature of all, and while great economies in fuel and water are obtained, yet the fact that for a given weight of locomotives having a high factor of adhesion it is possible to make a machine of at least 20 per cent greater hauling power, overshadows all other considerations. This is a fact of obviously more importance than the mere question of economies in coal and water.

The most extensive discussion on the paper was presented by Mr. Vaughan as follows:—

The committee's report in connection with the coal-saving on the Canadian Pacific Railway is a little bit mixed. It gives 42 per cent in one case and 3 per cent in another. These figures are widely varying. I understand that they have been obtained by following two engines. I have always objected to following an individual engine. I do not think our coal records are kept with sufficient accuracy to make comparisons between two engines of any value, so I had the figures compiled for a number of engines, some of which had been converted from 10-wheel passenger engines which were originally built as simples. These engines have been running in and out lately on two divisions, and without any change whatever except with the addition of the superheater, which gives us a temperature from about 530 to 550 degrees. On our Quebec section the non-superheater engines used 2,500 tons of coal during the period for which the records were taken, and the superheater engines took 2,000 tons, so that it was a fairly good test, as it extended over three or four months. The saving in fuel was 15.5 per cent for the superheater over the non-superheater. On another section, involving rather less coal, the saving was 33 per cent. I consider that excessive, and possibly due to the engines on that section having been through the shop later, or something of the sort. I see very little reason for questioning the figures we have got, and believe that you can depend on a saving of 10 to 15 per cent in freight service and 15 to 20 per cent in passenger service, by the use of superheater locomotives.

In the use of superheaters in Europe, they reach temperatures up to 600 degrees and over. We are using temperatures of 520 to 580 degrees, what would be known in Europe as moderate superheat. If you want to get any real benefit from superheaters you must go to a reasonably high temperature. I would like to see all of our engines give a superheat of 550 degrees, and, if possible, a little more. When you go up to that temperature you get the real benefits from superheating. When you use 40 degrees, 50 degrees or 60 degrees of superheat you get a little better working engine, but you have not really got into the superheating business at all and are simply playing with it. You might as well get into the business and use a reasonable amount of superheat and get the results that are obtained from the use of a moderate or high degree of superheat on locomotives.

The statement has frequently gone out in newspapers and pamphlets to the effect that high superheating—and I believe these statements refer to what I call moderate superheating—involves a number of new processes in the locomotive, and increased cost of repairs, etc. According to our experience these statements are absolutely wrong. We have put superheaters on ordinary simple piston valve engines without any change whatever other than the putting of the superheater into the boiler, and we really find no difference in the maintenance of the engine, with one exception, and that is the renewal of the piston rings. We have to replace piston rings more frequently on the superheaters than on non-superheating engines. The difference is especially noticeable in bad water districts, where there is considerable foaming. Both the piston and the valve rings wear out more quickly under these conditions on superheaters than on non-superheaters. We get from a month to six weeks' service out of the rings in very bad water districts, while they average from two to three months in good water districts, and they run as high as twelve to fourteen months. I am of the opinion that the ring question is largely a question of material, and you can get from three to six months' service in ordinary water from piston rings in superheated locomotives.

The valve rings, which gave trouble on superheater locomotives, did not give trouble in good water districts. We run our valve bushings, as a rule through two shoppings, and the rings are frequently run from shopping to shopping without attention. In other words, there is very little difference between the valve rings on superheaters and the valve rings on non-superheater locomotives.

We are unable to furnish figures as to the actual cost of repairs, for the reason that we have no simple engines with which to compare our superheaters. Based upon the size of the engine, or the tractive power, the cost of repairs of the superheater engine has been decidedly lower than the cost of repairs of simple engines. I have always felt that that result was due to the superheater being applied to locomotives of more modern type, and, of course, newer engines than the saturated steam-engines, and consequently the figures were not reliable. I have, however, the cost figures for several months for these 10-wheel passenger engines equipped with the superheaters, and the cost for repairing superheater engines was only 3.47 cents a mile, and the non-superheater engines were 3.5 cents, so that the cost was practically identical.

That substantiates what we have always felt, and that is while there is a slight additional expense for the maintenance of superheater locomotives on account of piston rings, there is a slight gain from the fact that you are always working dry steam, and these two things offset each other to a large extent. The only real additional expense in superheaters is a periodical testing of the front end. Our regulations call for a testing every three months to see that everything in the front end is tight. I do not know that it is entirely fair to call that an additional expense, because I do not think it is a bad thing to test the front end of the locomotive, whether it has a superheater or not. It is simply taking a proper precaution instead of waiting for failure. Before we adopted this method of testing we used to run through the summer months very successfully, but when the hard winter weather came on we had complaints of the engine being short of steam. We usually found the steam pipe leaking, or something of that sort. By making a periodic test in a systematic manner you overcome that condition, and keep the engines in good condition right along. I believe there is money in doing this. Another expense is keeping the tubes clean. We clean out the fire tubes every round trip, and, as far as I know, that is carried out religiously. It is only a half-hour's work for a man, a cheap class of labor, and it is not a very great expense.

As far as lubrication is concerned, we notice very little difference in using sight-feed lubrication, between the superheater and the non-superheater. We do not use slide valves on superheaters. It has been tried many times, and in every case is is found to give trouble. You have practically got to put up with piston valves if you go to the superheater locomotive, and I do not know that there is very much objection to using piston valves.

I have had the mileage made by the superheater locomotives in passenger service on the Canadian Pacific, Eastern lines, recorded for March and April. There were 790,000 miles made in the passenger service, and there was not a failure due to superheaters. That is a pretty good proof that there is no need for failures due to superheaters, if you will keep after them. Last year I gave figures that showed that we made over two million miles, and that there was no failure due to a superheater, that is, a passenger failure due to superheater itself.

It is a certain amount of satisfaction to me to feel that when we went into this business first we were criticised for putting so much apparatus in the front end. During the past few years everybody's opinion seems to have changed on that, and there

seems to be no objection to putting in two or three front ends and filling them with apparatus. We have used the intermediate superheater, by which I mean a boiler with an evaporating section at the back, the superheater in the middle. I won't say a feed water heater, but a front section into which the water is delivered. That engine was originally built as a reheater engine; in other words, the superheater was put in between the high and low pressure cylinders. We subsequently changed it over and put the superheater ahead of the high pressure cylinder. With the superheater acting as a reheater, we were getting ninety degrees superheat in the low pressure steam chests. With the superheater ahead of the high pressure, we obtained from 480 to 580 degrees in the high pressure steam chest; that is, a superheat of 100 to 200 degrees, varying, I think, according to the amount of water that was lifted by the engine, but we obtained very fairly uniformly 30 degrees of superheat in the low pressure steam chest. We didn't make any test on the two engines with the two arrangements. Our opinion was that it simply was not necessary. You could tell by the engine, by the fireman, that there was no comparison between the compound engine using the superheater ahead of the high pressure cylinder and one using no superheat in the high and superheat in the low. It made a different engine out of it. We shall not worry very much about experimenting with reheating. If you can run with 100 to 150 degrees of superheat on a high pressure cylinder, you are fairly safe in knowing that you are going to have a certain amount of superheat in the low pressure steam chest, and that there will be sufficient there to entirely avoid any water troubles in the low pressure cylinder. I feel that if we put in so much of a superheater that we get more superheat than we want in the high pressure steam chest, there is no advantage in going to reheating. We had better put all our heating surface where it does the most good.

I would like to ask Mr. Cole where he has proven that lowering the steam chest pressure is an advantage. I can see that lowering the boiler pressure is an advantage, if the boiler pressure is so high that you are having an abnormal amount of trouble with the boilers. We are running engines with two boiler pressures. In other words, we build a 21-in. engine with 200 lbs. pressure, and a 22½-in. engine with 175 lbs. pressure. We really set the pops at 180 on the lower pressure engine, to avoid the objection made by the engineers that they couldn't get the work out of the 175 lb. engine that they did out of the 200 lb. As a matter of fact, I think there was nothing to that, but their idea was that the more pressure they had, the more business they could do, it didn't make any difference what the size of the cylinder was. In order to avoid criticism, we gave the other engine 5 lbs. more so that she could pull just a little more. I watched those engines very carefully, and I do not see either theoretically or practically, any advantage whatever in reducing the boiler pressure unless you want to do it to save the boilers. In good water districts we certainly do not have trouble enough with the 200 lbs. pressure to make it any serious advantage to go to 180. In bad water districts we do notice a difference and we arrange to use engines with 175 or 180 lbs. pressure, but where you have reasonably good water, I fail to see any advantage whatever in reducing boiler pressures. I grant you that with superheated steam, you can reduce boiler pressures without losing efficiency, a thing that you could not do if you were using saturated steam; but I do not see any reason for obtaining greater efficiency, and I do feel most distinctly that the lower pressure engines, with bigger cylinders, are not as fast or as good as engines with the high pressure. I do not believe there is any difference in the pressure at the nozzle on either engine, and with the big cylinder you lose a greater percentage due to back pressure.

We have not built our passenger engines with 180 lbs. pressure, simply because we felt that a 200 lbs. engine was a faster and a better one. I have heard the statement made a number of times that you can obtain greater economy by reducing the boiler pressure, and I would like to know how it has been proved out, and why it is.

Other members reported satisfactory results with superheaters of various kinds.

Mr. Cole in answering Mr. Vaughan's question about low steam pressure stated that it was a matter of boiler repairs rather than a matter of superheating, in as much as any required temperature could be attained by the superheater in any case.

STEEL TIRES

Committee:—A. Stewart, chairman; A. S. Vogt, William Moir, E. D. Bronner, and H. D. Taylor.

The committee appointed to consider specifications for steel tires has been in communication with the tire manufacturers, some of the committee visiting the tire works with the idea of trying to work out specifications which it would be possible to enforce and not impose unnecessary hardships on the manufacturer or excessive cost to the purchaser. The results have not been encouraging, and we feel that any specification we could get up, to give any practical results, would require a test to destruction of at least one finished tire out of each heat. In view of the cost of carrying out a specification containing this requirement, we hesitate to offer it, and, unless it is the opinion of this Association that such a requirement, with the expense of enforcement, would be justified, we ask that the committee be discharged.

Discussion.—It was clearly brought out by the remarks of the members that by far the greatest trouble is being caused by tires under tenders. Very few reported any trouble with driving wheel tires, but practically every one that spoke had had difficulty with tender wheels.

Mr. Vaughan was not in favor of adopting a specification and his investigation of the subject showed that in many cases the trouble is due to the temperature at which the tire is finished. He was also of the opinion, although not positive, that the type of truck has some influence. On one very difficult division he had substituted the pedestal passenger type of truck for the previous diamond type and it greatly relieved the difficulty which, in his case, was confined almost entirely to service during the the winter months.

Other members who had tried Vanadium steel for tires reported that they had not been able so far to discover any increased wearing qualities, although their experience as yet had not been very extensive. Some members who had tried the 4 and 4½ in. tires reported them not as successful as the 3½ in. The character of the centre on which the tire is shrunk is also mentioned as having a considerable bearing on the life of the tire.

Upon motion, the report of the committee was received and referred to the executive committee for such action as they saw fit to take.

DESIGN, CONSTRUCTION AND INSPECTION OF LOCOMOTIVE BOILERS.

Committee:—Theo H. Curtis, Chairman; H. W. Jacobs, A. E. Manchester, D. R. MacBain, A. W. Gibbs.

The committee has not as yet had time to enable it to formulate rules and regulations covering the inspection of locomotive boilers, but it has thoroughly investigated the subject of boiler explosions and failures and casualties to employees and others resulting therefrom.

Blanks were forwarded to all of the principal railroads of the United States, asking for information in regard to boiler inspection rules and regulations and also as to casualties resulting from boiler explosions of all natures, and attention is called to the following information received in reports from 157 railroads replying to the question as to the number of boiler explosions and failures and casualties to employees and others resulting therefrom during the period from January 1, 1905, to November 1, 1909. These 157 railroads own and operate 43,787 locomotives and 157,169 miles of roadway, and during the period from January 1, 1905, to November 1, 1909, they made 6,012,057,467 locomotive miles. We estimate that there are about 58,000 locomotives in service in the United States; therefore, the reports which we have received cover about seventy-five per cent. of the total number of locomotives in operation in the United States.

Explosions and failures of locomotive boilers are divided into five classes, as follows:

Explosions of boiler shells,
Explosions of fire boxes,
Damage by burning,
Rupture of flues,
Boiler-fitting failures.

Explosions of boiler shells and fire boxes, or damage by burning, etc., are usually due to low water. Of the failures reported, 98.3 per cent. were due to low water and 1.7 per cent. to other causes.

Of the failures due to low water, 98.6 per cent. were due to the failure of the men handling or in immediate charge of the locomotive to maintain a proper supply of water in the boiler; the remaining 1.4 per cent. were due to other causes.

Automatic devices, either to maintain the water supply or to act as an alarm when proper supply is not provided, have been proposed and given consideration, but it has been determined that such devices are unreliable and have had the effect of taking away from the men in charge their accepted responsibility.

A statement of the explosions, failures and casualties is shown below:

	No.	Average per Year.	No. Killed.	Average per Year.	No. Injured.	Average per Year.
Low Water:						
Explosion of boiler shells.	14	2.9	20	4.1	16	3.3
Explosion of fire boxes...	246	50.9	127	26.3	144	29.8
Damaged by burning......	2,499	517.0	15	3.1	57	11.8
Ruptured flues	66	13.6	0	0.0	3	0.6
Fitting failures	25	5.2	0	0.0	4	0.8
Other Causes:						
Explosion of boiler shells.	6	1.3	10	2.0	7	1.4
Explosion of fire boxes...	2	0.4	1	0.2	1	0.2
Damaged by burning.....	40	8.3	1	0.2	1	0.2
Total	2,898	599.5	174	35.9	233	48.1

In the above table, of the 407 killed and injured, 386, or 94.8 per cent., were due to accidents caused by low water, while the remaining 21, or 5.2 per cent., were from other causes, some of these being the result of or incident to wrecks, and a small number are thought to be due to accidents caused by defects in design, material, workmanship or the physical condition of the boilers or fittings, but it is doubtful if any of them could have been prevented by any method of inspection in addition to that which is now in force.

In addition to the failures as shown above, there were also other failures, as follows:

	No.	No. Killed.	No. Injured.
Rupture of flues.................	3,204	8	21
Boiler fitting failures.............	1,609	2	51
Total	4,813	10	72

In analyzing the accidents due to the latter causes, attention is invited to the item of ruptured flues, shown to be 3,204. This, however, covers the record of an average number of 42,200 locomotives per annum for a period of four years and ten months. Assuming 250 flues to each locomotive boiler, the result shows one flue failure per year to each 15,912 flues in service, or, stated in other terms, the percentage of flue failures to the number of flues in service is six one hundred thousandths of one per cent.

Both of the above comparisons constitute an excellent endorsement of the present high standard of physical condition of American locomotive boilers, and show how small an opportunity there is to improve the present practice of railroads.

Of the 1,634 cases of boiler fitting failures reported, 1,609 are somewhat indefinite and apparently include failures occurring from causes other than the primary failure of the fittings, such as wrecks or other external accidents, many of them doubtless being of a minor character.

At the time the different railroad companies were asked for information as to boiler explosions, casualties, etc., they were also asked to supply copies of their rules and regulations for the care and inspection of locomotive boilers. A review of such rules and regulations as were submitted shows that a very thorough and vigorous inspection of locomotive boilers is being maintained and recorded, and the rules prescribe very thorough instructions as to the proper care of the locomotive boilers.

These rules and regulations plainly show that different localities require different rules and regulations for the care and inspection of locomotive boilers.

In some localities the water that is obtainable for use in these boilers is very detrimental to the boiler; therefore, very frequent inspections must be made, while in other localities the water conditions are very favorable and the period between inspections may be longer. In a general way, the rules and regulations for the care and inspection of the boilers must be made to meet the conditions under which the boilers are being operated, and no general rules will apply in a practical way.

From Senate Document No. 682, the following information was obtained: The average number of employees killed and injured per annum, on account of boiler explosions on locomotives, for the period from August 1, 1903, to November 1, 1908, was 49.7 employees and others killed and 134.2 injured. This Senate document covered a period of five years and three months and includes all the locomotives in use during that time.

During the period from January 1, 1905, to November 1, 1909 (four years and ten months), the replies from 157 railroads, having 43,787 locomotives, with a mileage of 6,012,057,467 miles, show that for said period the average number of employees killed and injured per annum was 38.0 killed and 63.1 injured. As the roads replying only represent about seventy-five per cent. of the locomotives in the country, it will be assumed that the figures represent about seventy-five per cent. of the casualties, which would make these figures approximate those furnished by the Government as to the number of persons killed and injured.

This report was given a very lively discussion, which, however, was of such a nature that a motion was carried to submit it to the executive committee before permitting its publication.

WIDENING GAUGE OF TRACKS AT CURVES.

Committee:—F. M. Whyte, Chairman; F. C. Cleaver, W. H. Lewis.

Various joint meetings have been held and the committee of this Association has from year to year reported progress to the convention. At the present time, however, it is possible to make the final report for your approval. The substance of the report was reported by the American Railway Engineering and Maintenance of Way Association, at their meeting last winter, and was adopted, so that, inasmuch as the subject interests that department more than it does the Motive Power department, it would appear to remain for this Association only to approve the report and the action taken. The recommendation is as follows:

"Curves eight degrees and under should be standard gauge. Gauge should be widened ⅛ inch for each two degrees or fraction thereof over eight degrees, to a maximum of 4 feet 9¼ inches for tracks of standard gauge. Gauge, including widening due to wear, should never exceed 4 feet 9½ inches.

"The installation of frogs upon the inside of curves is to be avoided wherever practicable, but where unavoidable the above rule should be modified in order to make the gauge of the track at the frog standard."

On motion of Mr. Seley the report of the committee was adopted and the committee was discharged.

CONSOLIDATION.

The report of this committee is reprinted in abstract, in connection with the proceedings of the M. C. B. Association, on page 282 of the July issue.

Discussion.—Inasmuch as the M. C. B. Association has placed the report of the committee on the table for a year and referred the matter to the executive committee for an investigation of the legal features involved this association followed the same procedure.

CAR PERFORMANCE OF BEACH BATTERY CAR*

The following is the performance of the Beach Storage battery car from March 2 to June 2, 1910, on the 28th Street Crosstown Line in New York City, operating in passenger service with a regular schedule of 4.77 m. p. h., and 8 stops per mile between the east and west side ferries, and with only one battery charge per day. During this time there were no interruptions of service, the car operating in all kinds of weather with snow, sleet and rain. There were no repairs necessary except replacing one motor brush and replacing eight lamps.

Period of time, days..........	90
Condition of track..........	Very poor, no maintenance
Kind of rail..........	47 to 109 lbs.
Maximum grade, per cent..........	3½
Length of grade, feet..........	3,000
Number of curves per trip..........	46
Length of route, miles..........	4.77
Type of car..........	Single truck
Type of battery..........	Edison
Number of cells, driving..........	100, A-8
Number of cells, lighting..........	5
Mileage capacity of car per battery charge..........	86
Maximum speed, miles..........	15
Charging period of battery, hours..........	7 at 193.3 V., 30 Amp.
Seating capacity	26
Weight of car complete, lbs..........	10,000
Average load weight, lbs..........	2,400
Maximum number of passengers, 5-23-10..........	70
Average number of passengers..........	15
Car miles covered during the period..........	5,512.50
Car miles per day..........	57.25
Battery intake per day, watt hours..........	41,054
Current consumption per day at brushes, watt hours..........	25,453
Ave. current consumption per car mile based on battery intake, w. h.	717.80
Ave. current consumption per car mile at brushes, w. h..........	527.40
Ave. current consumption per ton mile based on battery intake, w. h.	99.70
Average current consumption per ton mile at brushes, w. h..........	73.20
Running speed between stops. m. p. h..........	5.74

* For general description see p. 194, May, 1910. The size of battery cells has been changed to A-8.

MASTER CAR BUILDERS ASSOCIATION

FORTY-FOURTH ANNUAL CONVENTION.

(CONTINUED FROM PAGE 288.)

TESTS OF BRAKE SHOES.

Committee:—W. F. M. Goss, Chairman; William McIntosh, J. R. Onderdonk.

In addition to its usual duty of investigating the properties of brake shoes, the committee has also been requested by the Executive Committee of the Association to consider and report upon the standards applying to brake beams. This report accordingly deals with both subjects.

BRAKE SHOES.

Routine Tests.—Since the presentation of its last report the committee has received from Mr. B. P. Flory, of the New York, Ontario & Western Railway Company, one brake shoe to be tested to determine its frictional qualities. The results of the tests are presented in Appendix C.

Researches of the Year.—Previous to 1907, the work of the committee consisted chiefly in determining the frictional qualities of brake shoes and in recommending specifications concerning their coefficients of friction. In 1907, and again in 1908, the researches of the committee were extended to include an investigation of the wearing qualities of shoes. In the reports of 1907 and 1908 there are presented certain data concerning the wear of shoes which, however, were not considered sufficient to warrant any recommendation concerning a specification with respect to wear, the chief lack being in any information concerning the effect of the shoes upon the wheel itself. To supply this deficiency, a wheel scale, referred to in the report for 1909, was purchased, and has been in operation during the current year. By its use, it has been possible to determine the loss of weight in the wheel under the action of the shoe, as well as the loss in the shoe itself.

In pursuance of the program outlined in previous reports and approved by the Association, the committee at the beginning of last year selected from cars in service twenty-eight brake shoes which are believed to be representative of the shoes now in use on the railways of the country. These twenty-eight shoes are of fourteen different kinds, each kind in duplicate. One set of fourteen shoes was submitted to the tests outlined below in the Master Car Builders' laboratory at Purdue University. The other set was tested upon the brake-shoe testing machine of the American Brake Shoe and Foundry Company, at Mahwah, New Jersey. A list of these twenty-eight shoes is given in Table I, which also presents their trade names and other information.

SERIAL NO.	PURDUE LABORATORY NO.	DESIGNATION	OBTAINED FROM	MARKS FOUND ON SHOE
1	2	3	4	5
1	281	PLAIN CAST IRON	TRUCK IN C.&N.W. SHOPS	C.&N.W. 8386
2	282		" " " "	C.&N.W. 8386 (NO NOT CLEAR)
3	283	PLAIN CAST IRON - WITHOUT REINFORCEMENT	C.&N.W. CAR NO. 52327	2100 C
4	284		C.&E.I. CAR NO. 61561	5170
5	285	CONGDON 7 INSERTS	TRUCK IN C.&N.W. SHOPS	C.&N.W. 8386
6	286		" " " "	C.&N.W. 8386-1
7	287	CONGDON - STEEL BACK 5 INSERTS	C.&N.W. CAR NO. 9512	CC2 & G
8	288		C.&N.W. CAR NO. 10356	CC2 & G
9	289	STREETER - STEEL BACK	I.C. CAR NO. 23572	(NONE FOUND)
10	290		C.&N.W. CAR NO. 8460	(NOT DISTINGUISHABLE) & S
11	291	LAPPIN - CHILLED ENDS	C.&N.W. CAR NO. 95526	4 1193 FREIGHT N.Y.C. LINES
12	292		" " " "	4 1193 FREIGHT N.Y.C. LINES
13	293	LAPPIN - CHILLED ENDS	C.&E.I. CAR NO. 587	4 1193 FREIGHT N.Y.C. LINES
14	294		N.Y.C.H.R. CAR NO. 69732	N.Y.C. LINES FREIGHT
15	295	PLAIN CAST IRON - STEEL BACK	F.W. SARGENT, AMER. B.S.&F. CO.	(NOT NOTED)
16	296		" " " " "	PATENTED D 3 N-5470-4-1193
17	297	COLUMBIA	B. D. LOCKWOOD - FROM C.H.&D. CAR	(NOT NOTED)
18	298		" " " " "	C. H. & D. 1507
19	299	DIAMOND S - STEEL BACK	WM. MCINTOSH - FROM C.R.R. N.J. STOCK, APPLIED IN SERVICE THEN REMOVED	G 724 4
20	300		DITTO	G 724 4
21	301	WALSH	J. A. SPOOR OF THE CHICAGO JCT. RY.	(PRICK PUNCHED) C J
22	302		" " " " " "	(PRICK PUNCHED) C J
23	303	PITTSBURG - MALLEABLE SHELLS	E. F. NEEDHAM OF THE WABASH R.R.	PITTSBURG BRAKE SHOE CO. PITTSBURG, PA.
24	304		" " " "	PITTSBURG BRAKE SHOE CO. PITTSBURG, PA.
25	305	PITTSBURG - STEEL SHELLS	" " " "	PITTSBURG CO. BRAKE SHOE, PITTSBURG, PA.
26	306		" " " " "	PITTSBURG CO. BRAKE SHOE
27	307	NATIONAL	W. F. BUCK OF THE A.T.&S.F. RY.	(NOT DISTINGUISHABLE)
28	308		" " " " "	38 (NO NOT CLEAR)
14 SHOES WITH EVEN SERIAL NOS. SENT TO PURDUE UNIVERSITY LABORATORY				
14 " " ODD " " " " AMER. BRAKE SHOE & FOUNDRY CO.				

TABLE I.—INFORMATION FOR SHOES USED IN TEST.

These shoes have been tested under the following schedule:

A. Tests to determine the coefficient of friction of the shoe under the current specifications.

B. Tests to determine the loss in weight of the shoe under repeated applications.

C. Tests to determine the loss in weight of the wheel under the repeated application of the shoe.

The fourteen shoes submitted to the Master Car Builders' laboratory at Purdue University were subjected to the entire schedule. The detailed report submitted by the authorities of Purdue University is included as Appendix A (not reproduced here). The shoes submitted to the American Brake Shoe and Foundry Company were tested only for coefficient of friction, and the report of these tests is included as Appendix B (not reproduced here).

COEFFICIENT OF FRICTION

Each of the twenty-eight shoes has been tested to determine its coefficient of friction under the current specifications of the Association. The coefficient of friction has been determined on a cast-iron chilled wheel in effecting stops from an initial speed of forty miles per hour under three brake-shoe pressures, namely, 2,808, 4,152 and 6,840 pounds. The coefficient of friction has been determined on a steel-tired wheel in effecting stops from an initial speed of sixty-five miles per hour under shoe pressures of 2,808, 6,840 and 12,000 pounds. The fourteen shoes sent to the American Brake Shoe and Foundry Company were also tested on the steel-tired wheel under intermediate and higher pressures.

The results of these tests, which are included in the reports of Purdue University and the American Brake Shoe and Foundry Company, have been summarized and are displayed in Table 2.

The coefficients of friction obtained by the American Brake Shoe and Foundry Company on their testing machine are, at the lower pressures, about the same as those obtained upon the Master Car Builders' standard machine; but at the higher pressures they are considerably lower. The explanation for such differences probably lies in the fact that the flywheel of the former machine is heavier and has, at a like speed, greater kinetic energy than the flywheel of the standard machine. As a result of this, the stops made with the former machine are longer and result in greater heating of the shoe. Because of this difference in the construction and in the characteristics of the two testing machines, the committee has limited its consideration to the results obtained in the laboratory of the Association at Purdue University, in determining upon its recommendations concerning coefficients of friction.

From its consideration of the results obtained upon the cast-iron wheel the committee has decided to recommend that shoes when tested upon a cast-iron wheel, in effecting stops from an initial speed of forty miles per hour, shall develop a mean coefficient of friction of not less than

22 per cent. when the brake-shoe pressure is 2,808 pounds.

16 per cent. when the brake-shoe pressure is 6,840 pounds.

The only change from the current specification involved in this recommendation is the omission of the specification at the intermediate pressure of 4,152 pounds. With rare exceptions, the shoe which meets the specifications at the two pressures stated will also meet them at the intermediate pressure, and the test at the third pressure is, therefore, considered to be unnecessary.

The current specifications require shoes to be tested on the steel-

TABLE 2

THE MEAN COEFFICIENTS OF FRICTION DEVELOPED BY EACH OF THE SHOES ON BOTH THE CAST IRON WHEEL AND THE STEEL-TIRED WHEEL

SHOE NUMBER	LABORATORY AT WHICH THE TEST WAS MADE	MEAN COEFFICIENT IN PER CENT. INITIAL SPEED OF 40 M P H CAST IRON WHEEL — SHOE PRESSURE-LBS.			MEAN COEFFICIENT IN PER CENT STOPS FROM AN INITIAL SPEED OF 65 M.P.H STEEL-TIRED WHEEL — SHOE PRESSURE — LBS						
		2808	4152	6840	2808	4152	6840	10000	12000	15000	18000
281	A.B.S.&F.Co.	26 3	21.7	21.0	16 3	13.1	11.0				
282	PURDUE	22.1	21.6	20.4	16 0		12.4		10.4		
283	A.B.S.&F.Co.	25.1	23.5	20.6	—	—	11.7				
284	PURDUE	30.3	27.7	24.5	16.3		13.5		11.6		
285	A.B.S.&F.Co.	26.8	19.0	15.3	19.7	17 7	12 4	8.9	9.4	8.1	7.7
286	PURDUE	22.2	19.8	16.4	20.6		14.0		11.3		
287	A.B.S.&F.Co.	25.0	18.3	17.2	20.3	18.0	11.8	9.5	9.8	8 5	7 6
288	PURDUE	24.4	22.6	19.1	15.1		11.9		11.7		
289	A.B.S.&F.Co.	24.5	22 6	19.0	16.9	14 9	11.1	11.7	10.4	9.5	9.1
290	PURDUE	21.8	20.6	16.4	13.6		10.8		10.7		
291	A.B.S.&F.Co.	18.2	16.8	16.1	15.0	13.4	10.1	8.8	6.6	8 8	6.8
292	PURDUE	20.5	19.6	18.9	17.0		13.0		11.1		
293	A.B.S.&F.Co.	20.5	18.4	14.3	16.3	15.1	11.6	9.1	9.3	7.9	6 6
294	PURDUE	18.4	17.8	17.5	16.9		12.7		17.2		
295	A.B.S.&F.Co.	27.0	25.1	21.9	16 9	13.5	11.3	9 7	8.4	9.3	8.5
296	PURDUE	21.0	20.3	18.5	16.2		13.2		11.1		
297	A.B.S.&F.Co.	27.0	28.6	21.8	18.4	14 0	13.5	—	- -	—	—
298	PURDUE	21.0	18.9	17.3	16.8		13.1		10 7		
299	A.B.S.&F.Co.	24.2	20.0	16.2	21.5	17.4	13.5	11.2	10.8	9.8	9.8
300	PURDUE	22.8	20.5	18.3	17.3		13.6		12.3		
301	A.B.S.&F.Co.	22.6	20.0	14.9	14 7	12.1	10.3	8.7	8.6	9.1	8.7
302	PURDUE	23.7	20.5	19.8	16.6		14.4		11.5		
303	A.B.S.&F.Co.	24.4	21.9	17.0	17.7	17.9	17.5	14.0	11.8	11.2	10.7
304	PURDUE	26.8	25.4	21.5	22.8		18.9		17.6		
305	A.B.S.&F.Co.	29.9	29.6	24.2	23.0	20.9	18.7	15.8	14.7	14.2	15.3
306	PURDUE	29.4	27.5	23.4	25.8		23.2		22.2		
307	A.B.S.&F.Co.	16.3	15.2	11.9	15.1	11.3	9.8	8.2	7.5	6.9	8.3
308	PURDUE	19.3	16.4	14.3	15.2		12.1		11.2		

tired wheel at three different pressures. For the reasons just stated, the committee believes that tests under two pressures will be sufficient. In order to have the test conditions more nearly like those which prevail in practice, it seems desirable that the higher of these two shoe pressures should be 12,000 pounds. The committee accordingly recommends that shoes, when tested upon a steel-tired wheel, in effecting stops from an initial speed of sixty-five miles per hour, shall develop a mean coefficient of friction not less than

12½ per cent. when the brake-shoe pressure is 6,840 pounds.
11 per cent. when the brake-shoe pressure is 12,000 pounds.

This recommendation involves dropping from the current specifications the tests at pressures of 2,808 and 4,152 pounds and substituting therefor a test at a pressure of 12,000 pounds. The test at 6,840 pounds shoe pressure is retained; but the coefficient is increased from 12 per cent. to 12½ per cent.

The Association has, for some years, specified that the rise in the coefficient of friction at the end of a stop should not exceed 7 per cent. The experience of the laboratory during the past four or five years indicates that a shoe which meets the specification concerning the *mean* coefficient also generally meets this requirement concerning the final coefficient. Whenever a shoe develops a final coefficient of friction in excess of the specifications it does so only within 4 or 5 feet of the end of the stop; and it is not likely, therefore, to have any harmful effect in service. For these reasons the committee believes that the specification concerning final coefficient of friction may properly be omitted from the standards of the Association, and it so recommends.

SHOE WEAR AND WHEEL WEAR.

Each of the fourteen shoes submitted to the laboratory at Purdue University was tested to determine its wear under repeated applications to both the cast-iron and the steel-tired wheel under the conditions cited below. Under these same conditions, the loss in weight of the wheel under the action of the shoe was determined by means of a scale especially designed for the purpose, which was referred to in last year's report. The shoe wear and wheel wear tests were run under the following conditions:

A. On the cast-iron wheel—At a constant speed of 20 miles per hour and at a shoe pressure of 2,808 pounds.

B. On the steel wheel.—At a constant speed of 20 miles per hour and at a shoe pressure of 2,808 pounds.

C. On the steel wheel.—In effecting stops from an initial speed of 65 miles per hour and at a shoe pressure of 12,000 pounds.

During the tests at the lower pressure (conditions A and B) most of the shoes were applied 300 times to the wheel, while the latter was kept running at a constant speed of twenty miles per hour. A few of the thinner shoes were given only 200 applications, and in one case 100 applications only were made. These applications of the shoe to the wheel were made by means of an automatic device on the testing machine which operates to keep the shoe in contact with the wheel for about one minute, while the interval between contacts is about three minutes. At the end of each 100 applications, both the shoe and the wheel were weighed to determine the metal lost by abrasion.

The tests on the steel wheel at the higher pressure (condition C) were made by a process similar to that employed in determining the coefficient of friction. In most cases, nine stops were made from an initial speed of sixty-five miles per hour, after which both the shoe and the wheel were weighed to determine their loss. With two of the shoes, the number of stops was reduced to six instead of nine.

The results of the tests to determine shoe wear are summarized in Table 3, and the results of the wheel-wear tests are shown in Table 4.

Results of the Tests on Wheel Wear.—At a shoe pressure of 2,808 pounds, the only shoe which produced an appreciable wear on the cast-iron wheel is the Congdon shoe, No. 286. It is somewhat significant that this is the shoe showing the least shoe wear. During the tests on the steel wheel, at a pressure of 2,808 pounds, only two shoes caused any considerable wear of the wheel. These are numbers 286 and 288, both Congdon shoes. Shoe 286, which was given 300 applications to the wheel, cut four V-shaped grooves about 1-32 inch deep and several smaller ones around its entire circumference. Shoe 288 had scored the wheel in a similar manner with five grooves after 100 applications. During the tests on the steel wheel at a pressure of 12,000 pounds, only two shoes produced any wear whatever on the wheel, and this was quite inconsiderable in amount. These shoes are Nos. 304 and 306, both Pittsburgh composition shoes. These two, however, did not score the wheel.

TABLE 3.—TEST TO DETERMINE SHOE WEAR.

SHOE NUMBER	DESIGNATION OF THE SHOE	LABORATORY AT WHICH THE TESTS WERE MADE	WHEN TESTED ON THE CAST IRON WHEEL		WHEN TESTED ON THE STEEL-TIRED WHEEL			
			NUMBER OF APPLICATIONS	SHOE PRESS.-2808 LBS. SHOE LOSS, IN POUNDS PER 100,000,000 FOOT-POUNDS OF WORK DONE	NUMBER OF APPLICATIONS	SHOE PRESS. 2808 LBS. SHOE LOSS, IN POUNDS PER 100,000,000 FOOT-POUNDS OF WORK DONE	NUMBER OF APPLICATIONS	SHOE PRESS.-12000 LBS. SHOE LOSS, IN POUNDS PER 100,000,000 FOOT-POUNDS OF WORK DONE
282	PLAIN CAST IRON	PURDUE	400	745	300	.856	9	1.917
284	PLAIN CAST IRON WITHOUT REINFORCEMENT	PURDUE	300	1.225	100	1.360	9	3 135
286	CONGDON	PURDUE	200	.163	300	.706	9	1.467
288	CONGDON-STEEL BACK	PURDUE	300	.212	100	633	9	1 405
290	STREETER-STEEL BACK	PURDUE	300	.433	300	.482	9	2.240
292	LAPPIN-CHILLED ENDS	PURDUE	300	592	300	.885	9	3.405
294	LAPPIN-CHILLED ENDS	PURDUE	300	572	300	.590	9	2 820
296	PLAIN CAST IRON STEEL BACK	PURDUE	300	.820	300	1.058	9	3 833
298	COLUMBIA	PURDUE	100	537	100	.592	9	1.594
300	DIAMOND S STEEL BACK	PURDUE	300	565	300	.662	9	2 925
302	WALSH	PURDUE	300	671	300	.784	9	8.780
304	PITTSBURG MALLEABLE SHELL	PURDUE	200	.292	200	.273	6	.705
306	PITTSBURG STEEL SHELL	PURDUE	200	239	200	.299	6	.918
308	NATIONAL	PURDUE	300	.396	300	.413	9	2 565

TABLE 4

RESULTS OF THE TESTS MADE TO DETERMINE WHEEL WEAR AT THE LABORATORY OF PURDUE UNIVERSITY.

		CAST IRON WHEEL		STEEL-TIRED WHEEL			
			SHOE PRESS.-2808LBS		SHOE PRESS-2808LBS		SHOE PRESS-12000LBS
SHOE NUMBER	DESIGNATION OF THE SHOE	NUMBER OF SHOE APPLICATIONS	WHEEL WEAR IN POUNDS PER 100,000,000 FOOT-POUNDS OF WORK DONE BY SHOE	NUMBER OF SHOE APPLICATIONS	WHEEL WEAR IN POUNDS PER 100,000,000 FOOT-POUNDS OF WORK DONE BY SHOE	NUMBER OF SHOE APPLICATIONS	WHEEL WEAR IN POUNDS PER 100,000,000 FOOT-POUNDS OF WORK DONE BY SHOE
282	PLAIN CAST IRON	400	0.0004	300	0.0046	9	NONE
284	PLAIN CAST IRON	300	NONE	100	NONE	9	"
286	CONGDON	200	0.0859	300	0.1685	9	"
288	CONGDON	300	0.0063	100	0.2330	9	"
290	STREETER	300	NONE	300	0.0192	9	"
292	LAPPIN-CHILLED ENDS	300	"	300	0.0003	9	"
294	LAPPIN-CHILLED ENDS	300	"	300	NONE	9	"
296	PLAIN CAST IRON	300	"	300	NONE	9	"
298	COLUMBIA	100	"	100	0.0123	9	"
300	DIAMOND S	300	"	300	0.0016	9	"
302	WALSH	300	"	300	NONE	9	"
304	PITTSBURG-MALL. SHELL	200	0.0045	200	0.0209	6	0.0940
306	PITTSBURG-STEEL. SHELL	200	0.0026	200	0.0192	6	0.1148
308	NATIONAL	300	NONE	300	0.0242	9	NONE

Conclusions Concerning Wheel Wear.—The results seem to warrant the conclusion that none of the ordinary shoes in service are likely to cause any appreciable wear on the cast-iron wheel. The wear on the steel wheel, while greater than on the cast-iron wheel, is likewise almost inconsiderable, except in the case of the two insert shoes above cited. The committee regards the scoring of the wheel in these two cases as more or less accidental, and experience with insert shoes in service seems to warrant this opinion. After consideration of all the facts here presented, the committee has concluded that no serious wear of the wheel is to be expected from the action of any of the shoes now in ordinary service, and it, therefore, considers any recommendation concerning wheel wear to be unnecessary.

The committee regards the reassurance which proceeds from such conclusions as ample return for the effort and expense which have been entailed by its research concerning the effect of brake shoes upon the wheel. Such conclusions also clear the way for a recommendation concerning the wear of the shoes themselves, which, until now, the committee has felt unable to make.

Results of the Tests on Shoe Wear.—The wear is represented in terms of weight lost by the shoe per 100,000,000 foot-pounds of work done. These weights may be accepted as measures of the relative durability of all of the shoes except the composition shoes, Nos. 304 and 306. The density of the shell and filler of these two shoes is less than that of the metallic shoes in the ratio of 1 to 2.4. To compare the durability of these shoes with the durability of the others, their actual loss in weight should, therefore, be multiplied by 2.4.

The facts may be generalized as follows:

a. The shoes tested present great variation in their wearing qualities, the ratio between the poorest and the best shoe being as great as 1 to 6.

b. The relative resistance to wear exhibited by different shoes is somewhat affected by the severity of the application. Of a series of shoes, the one which suffers least from wear at light pressures may not be the one which suffers least under a heavy pressure.

c. All shoes tested wear more rapidly on a steel-tired wheel than on a cast-iron wheel, when tested under like pressures.

d. In general terms, it may be stated that the shoes which show a wear greatly below the average are those which cause wear in the wheel.

e. All shoes show greater wear, per unit of work performed, when applied under the higher pressure. The ratio is occasionally as great as 1 to 10.

Recommendations Concerning Shoe Wear.—The committee recommends:

That on the cast-iron wheel the shoe wear be determined by making 100 applications of the shoe to the wheel, under a pressure of 2,808 pounds, and at a constant wheel speed of twenty miles per hour; at each application the shoe to be in contact with the wheel during 190 revolutions and out of contact during the succeeding 610 revolutions.

That, under these conditions, the shoe shall lose in weight not more than 0.8 of a pound for each 100,000,000 foot-pounds of work done.

That, on the steel-tired wheel, the shoe wear be determined by making ten stops from an initial speed of sixty-five miles per hour, and under a shoe pressure of 12,000 pounds.

That, under these conditions, the shoe shall lose in weight not more than 4.0 pounds for each 100,000,000 foot-pounds of work done.

That, in the case of non-metallic shoes, these limits of wear be reduced in the ratio of the density of their abraded parts to the density of cast iron.

Only one of the shoes tested on the cast-iron wheel and one of those tested on the steel wheel fail to meet the proposed specification. The shoes which develop a high coefficient of friction are also those which are likely to show the greater wear,

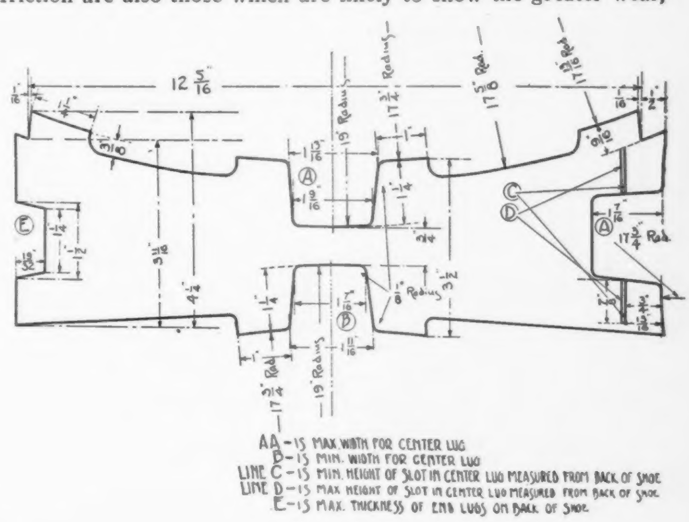


FIG. I.

and if, therefore, the proposed wear limits are made more exacting than is here proposed, almost all of the shoes which pass the specifications for coefficient of friction would be rejected under the specifications for wear.

For these reasons, the committee concluded that the wear limits should not be made more exacting than is proposed in the recommendations above; and it believes that the proposed wear specifications, when combined with the specifications concerning coefficient of friction, will serve their main purpose of protecting the purchaser against the unusually soft shoe.

SHOE GAUGE AND THICKNESS OF INSERTS.

Shoe Gauge.—The Association has a standard gauge for the brake head. Since the back of the shoe must fit this head, the committee believes that a limit gauge for the back of the shoe ought also to be added to the standards, and it proposes for this purpose the gauge shown in Fig. 1.

Thickness of Inserts.—In many insert shoes the inserts are so

thin that they are either worn through or drop out during the first quarter of the life of the shoe. The committee believes that inserts should be made as thick as the processes of manufacture will permit, and it recommends that in no case should the thickness of the insert in the new shoe be less than one-half of the total depth of the shoe.

BRAKE BEAMS.

After a study of all previous actions, the committee decided to limit its consideration of changes in standards to—(1) size of the hanger hole in the brake head, (2) certain changes in the specifications for beam tests, and (3) limiting dimensions governing the outline for brake beams. Suggestions concerning the three items were embodied in a circular of inquiry which was sent to the members in January.

The committee has invited the manufacturers of brake beams to send representatives to its meetings, and representatives of the following companies have been present during certain of its discussion:

The American Steel Foundries.
The Chicago Railway Equipment Company.
The Damascus Brake Beam Company.
The Davis Brake Beam Company.

The suggestions made by these representatives have been given due consideration along with the replies received to the circular of inquiry.

Brake Head Hanger Hole.—In the circular it was proposed to increase the size of the hanger hole sufficiently to permit the use of a 1-inch hanger as well as the ⅞-inch hanger. The change was suggested on account of the breakage of the ⅞-inch hanger under some conditions of service. To the inquiry on this point seventeen replies were received, twelve of which advocated the proposed change. In the five other replies the change is opposed only on account of the increased play which would be allowed when a ⅞-inch hanger would be used in the larger hole. In some of these replies the ⅞-inch hanger is held to be sufficiently strong, especially if it be made with a larger fillet at the bend than is at present customary. After considering all the replies, the committee has decided to recommend the proposed change, and it believes that the edges of the hole ought also be rounded out to permit the use of a filleted hanger. It, accordingly, recommends that the present standard brake head be so

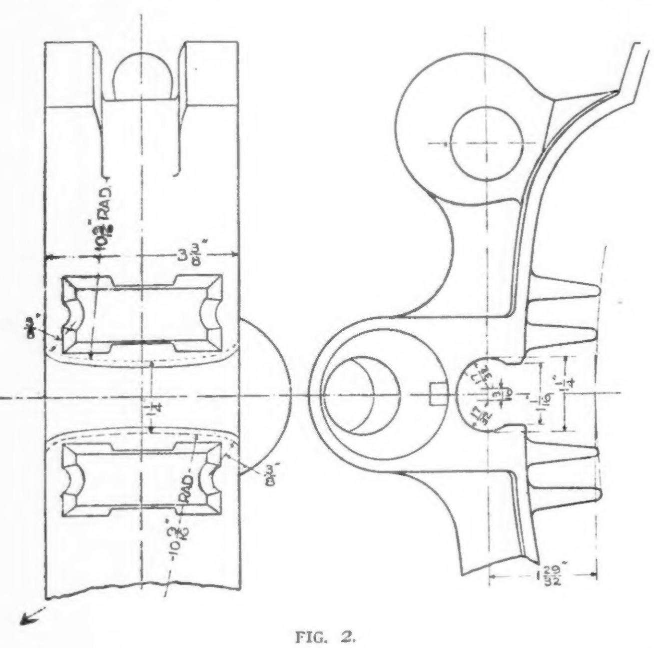


FIG. 2.

modified as to conform in these respects to the head shown in Fig. 2.

Specification for Tests.—The committee has reconsidered the current test specifications, and it believes that changes are desirable in the two respects referred to below.

The present specifications require that, as a preliminary to the deflection tests for both the No. 1 and the No. 2 beams, a load of 6,000 pounds be applied and then released; after which the load for producing deflection is applied. The committee believes that the preliminary load for the No. 1 beam should be reduced to 4,000 pounds, and it so recommends. It is thought that the change will result in more careful assembling of the beam.

The current specifications require no test for the ultimate strength of the beam. On account of the diversity in beam designs the deflection test gives but little information concerning their ultimate strength. The committee, therefore, considers it desirable that the beam be finally tested to destruction, and that under this test the maximum load borne shall not be less than

20,000 pounds for the No. 1 beam,
38,000 pounds for the No. 2 beam,

and it recommends that such tests be added to the specifications.

Paragraph 2, under "Brake Beams," on page 590 of the Proceedings for 1909, is in conflict with the test specifications. The committee recommends that it be omitted.

Brake-beam Limit Outline.—In its circular, the committee proposed the establishment of an outline which should serve to limit the dimensions of the beam. The purpose of the suggestion is to

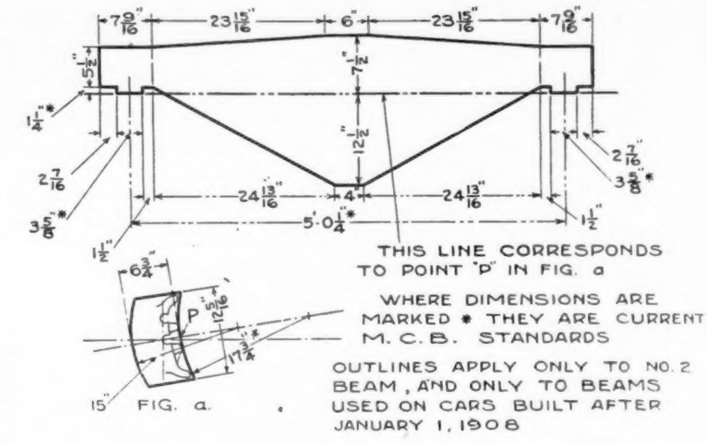


FIG. 3.

facilitate replacements of beams on cars in interchange. To the inquiry on this matter fifteen replies were received, in none of which was the feasibility of establishing such a limit called in question. The beam manufacturers have likewise endorsed the proposal. After consideration of the replies received from the railway companies and of the dimensions submitted by the manufacturers, the committee has prepared the outline which is represented in Fig. 3. It recommends that the Association adopt as a standard this outline within which all parts of the No. 2 beam must fall, it being further understood that the recommendation is to apply only to beams used on cars built after January 1, 1908.

Use of the No. 2 Beam.—The committee believes that the use of the No. 2 beam should be required on cars of more than 35,000 pounds light weight. The current standards are open to misrepresentation at this point. It, accordingly, recommends that the paragraph on page 591 of the Proceedings for 1909, which reads, "Beam No. 2 to be suitable for cars exceeding 35,000 pounds light weight," be changed to read: "Beam No. 2 must be used on cars of more than 35,000 pounds light weight, and it may be used on cars of 35,000 pounds light weight or less."

An Editorial Change in Current Standards.—On page 591 of the Proceedings for 1909, the last paragraph under the heading "Brake Beam Specifications and Tests" reads as follows: "On cars built after September 1, 1909, it will not be permissible to hang brake beams from any portion of the body of the car." The committee believes that this statement would more appropriately appear under the heading of "Brake Beams" in the preceding section, and recommends that it be shifted to that place.

Inside Hung Beams.—The Committee on Brake Beams, reporting in 1906, suggested for recommended practice that "all beams be inside hung." The whole report of this brake-beam committee was referred to the Committee on Standards, who, reporting in 1907, approved the recommendation noted above, provided it were construed as not requiring outside hung beams then in service to be changed.

All other recommendations of the Committee on Standards, except this one item, were submitted to letter ballot in 1907. There is nothing in the discussion before the convention to warrant this omission from the ballot, and that it was not there included is probably due to an error. Your committee, therefore, recommends that this provision be restored to the recommended practice of the Association.

Discussion—Mr. Burton asked for information concerning the coefficient of friction and wear resulting from continuous contact between the shoe and wheel in heavy grade service. Prof. Schmidt, who, in the absence of Dr. Goss, presented the committee's report, answered by saying that while no tests had been made directly covering this feature, there was no question but what the coefficient of friction decreased as the shoe got hot.

Mr. Young asked for information concerning the question of brake shoes on steel or steel tired wheels in freight service. He also drew attention to the fact that this committee gave results

from 12,000 lbs. brake shoe pressure, while the committee on brakes recommended 18,000 lbs. shoe pressure. Prof. Schmidt stated that the results for 12,000 lbs. would hold for 18,000 lbs. shoe pressure. He also said that the results on steel tired wheels in the report he thought would cover freight service as well as passenger.

The committee's report, as far as it refers to brake shoes, was then ordered to be referred to letter ballot.

The section of the report dealing with brake beams was amended by Mr. Seley, allowing a slight variation from the .0625 inch deflection permitted, and in that form was ordered submitted to letter ballot.

SPLICING UNDERFRAMING.

Committee:—R. E. Smith, Chairman; W. F. Bentley, I. S. Downing, H. L. Trimyer, F. A. Torrey.

The committee was continued from last year to investigate the following subjects:

(a) Maximum amount of sill splicing allowable, as referred to in Rule 65 of the Rules of Interchange.

(b) Strength of various forms of underframing.

RECOMMENDATIONS

A. Maximum amount of sill splicing allowable, as referred to in Rule 65 of Rules of Interchange:

1. That M. C. B. Rule 65 be changed to read as follows:

"Draft timbers must not be spliced. Longitudinal sills may be spliced at two points. No adjacent sills, except center sills, to have entire splice immediately opposite the splice on adjacent sill; splices to be staggered so as to make joint of one splice at least 24 inches from the joint of the splice on adjacent sill, measured from a line drawn at right angles with sills. Center sills must be spliced between body bolsters and cross-tie timbers, but not within 18 inches of either. Splices on all sills other than center sills, as provided for above, can be located at any point between body bolsters or between body bolster and end sill, but not within 12 inches of body bolster.

"When splicing longitudinal sills the plan shown in Fig. 9-B is to be followed.

"Any sill spliced after September 1, 1910, that does not conform to the above, will be considered improper repairs.

"Steel sills may be spliced in the most convenient location, in accordance with Figs. A, B and C. Adjacent steel sills may be spliced. The thickness of each splice must not be less than the thickness of the web of the section spliced."

2. That all figures showing plans for splicing wood sills in M. C. B. Rules be eliminated, except Fig. 9-B.

An analysis of the proposed rule will show that few restrictions have been placed upon the practice of economy in the use of high-grade material, which is rapidly becoming more costly and difficult to obtain; we do not feel that we have recommended too wide a latitude in the number of location of the splices.

It has, of course, been impracticable for the committee to conduct practical tests to demonstrate the soundness of its recommendations, because of the large scale upon which such tests would have to be conducted; and it is questionable whether the testing to destruction of any reasonable number of cars, with sills spliced in a variety of ways and locations, would conclusively confirm or disprove any theory or afford positive data from which to prescribe correct practice. There remained then, only judgment and experience upon which to base our recommendations, which are respectfully submitted.

STRENGTH OF VARIOUS FORMS OF UNDERFRAMING

As far as the committee has been able to go into the matter, it appears that there is but a small percentage of the total equipment of the country provided with partial metal underframes or subframes; that there is a clear distinction between cars with metal underframes, provision for which is distinctly made in Rule 113, and cars with partial metal underframes or subframes; in the former case the entire underframe is of steel, with superimposed or attached timbers of light section, serving merely as a means of securing the superstructure to the steel frame; in the latter case the partial metal underframe is really a subframe upon which the heavy longitudinal sills rest; or it may consist merely of two longitudinal members, placed parallel with or replacing the draft sills, and serving as a more substantial means of securing the draft rigging; in some designs the body bolsters are found riveted up with the frame; in others with the metal cross ties; in still others with both bolsters and cross ties; some are designed to dispense with the body truss rods; they are not in a strict sense car frames, but rather a form of continuous draft gear to which it has been found convenient to attach the body bolsters and cross ties. Some designs are patented, and the prices range between $40 and $300.

The committee is of the opinion that this form of rebuilding is not going to be extensively used. If it should, the question of the proper basis of settlement for cars so equipped, when destroyed on a foreign line, will become more pressing than it is to-day.

The committee does not feel that it can, at this time, make a recommendation as to the amount that should be allowed for each design that has come under its notice, and it does not believe that it has seen all designs now in use; nor can it suggest an allowance that would represent a fair average for all designs. The committee is of the opinion that the allowance of $40, provided in present Rule 113, is not excessive for any of the designs.

The report was referred to the arbitration committee to be considered next year.

TRAIN LIGHTING.

Committee:—T. R. Cook, Chairman, E. A. Benson, Carl Brandt, Ward Barnum, J. H. Davis.

The committee desires to suggest as recommended practice the following points:

(1) That each electrically lighted car be provided with a notice describing the apparatus in the car, in accordance with Fig. 1, and that this notice shall be posted in a conspicuous

A. B. C. R. R. CO.
ELECTRIC LIGHTING

System ....
No. cells in series ....
No. sets in parallel ....
Amp. hrs. capacity of battery (at 8 hrs. rate) ....
Normal charging rate .... Max. ....
Size of train line wires ....
Amp. discharge full light ....
Setting Axle generator ....
Cut in voltage ....
Amperes no light ....
Amperes full light ....
Axle pulley diameter ....
Generator pulley diameter ....

WIRING DIAGRAM
Show Capacity of Fuses

FIG. 1.

place in or near the switchboard locker.

(2) That where train line connectors are used, Gibbs' No. 3-G Train Line Connector be used, located as shown on Fig. 2,

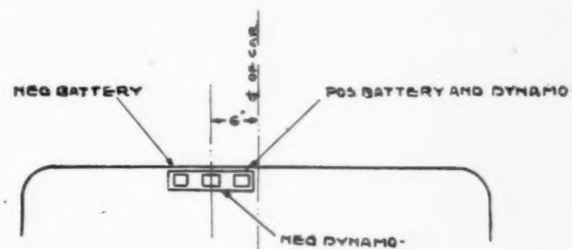


FIG. 2.

with connections to the battery, dynamo and jumper, as shown on Fig. 3.

(3) That batteries shall be connected up with the positive to the right, facing the car, as shown on Fig. 3.

(4) That where double compartment tanks are used, the connections and arrangement of battery terminals are to be as shown on Fig. 4.

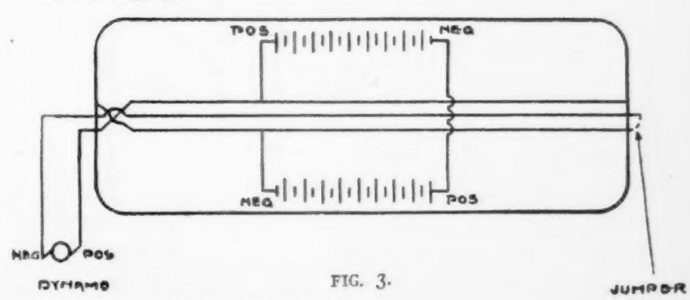


FIG. 3.

(5) That each electrically lighted car shall be provided with two charging receptacles with swivel supports, installed one on each side of the car, as shown on Fig. 5.

(6) That each electrically lighted car be provided with two 150 ampere fuses, close-connected to each battery terminal; the fuses to be arranged and placed in a cast-iron box, and installed on car, as shown on Fig. 5.

(7) That each electrically lighted car shall have provided on the switchboard in the car a switch, fused switch, or fuses. The switches or fuses to protect and completely disconnect the following parts:

(a) Train line (where train line is used),
(b) Battery,
(c) Axle dynamo (where axle dynamo is used).
(The axle dynamo switch or fuses to control the positive, negative and field of the dynamo.)

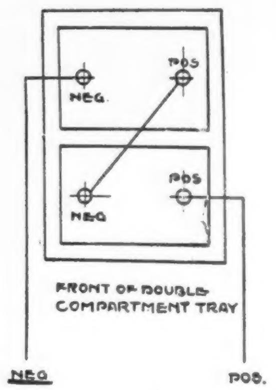


FIG. 4.

Each of the above switches or fuses to be plainly stenciled designating the part controlled.

(8) Where a main lamp switch is used, or where fuses controlling all lamps are used, they shall be so stenciled in plain letters.

(9) That all fuses on cars shall be National Electric Code fuses.

(10) That where axle dynamos are used, negative, positive and dynamo field shall be fused as close as possible to the dynamo and prior to the said leads either entering the conduits or being secured to the bottom of the car. The above fuses to be used for emergency service only and to be at least 100 per cent. above the capacity of the fuses on the switchboards protecting the same leads.

(11) That the following voltages should be used:

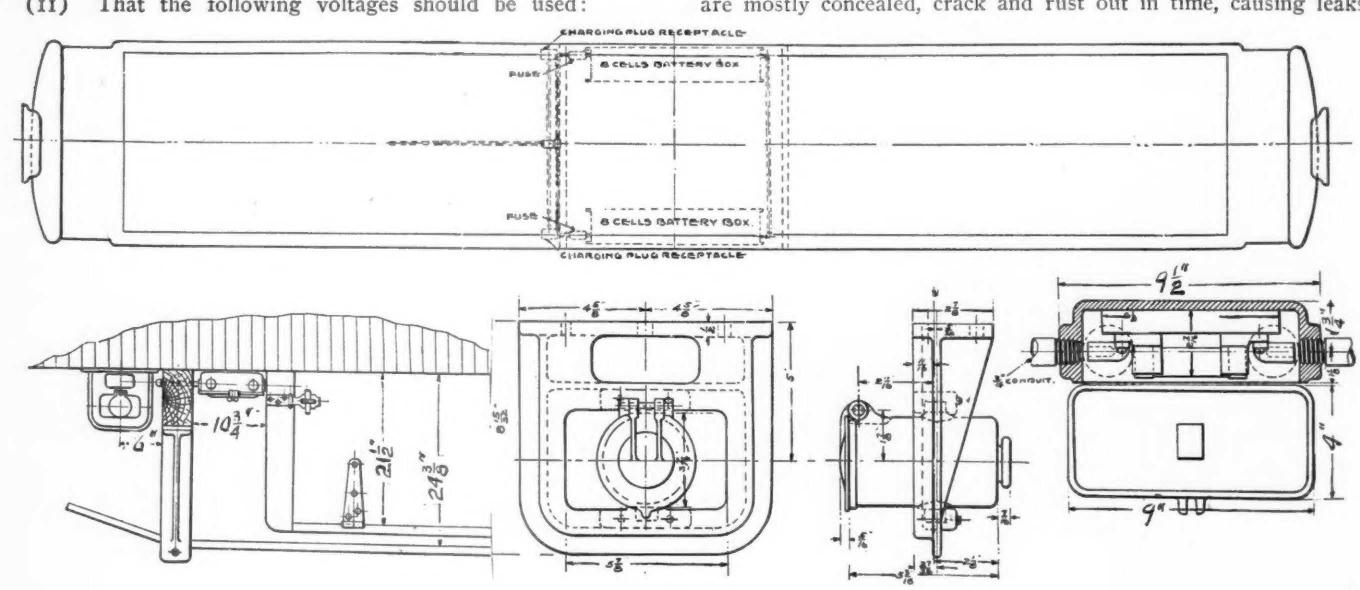


FIG. 5.

60 volts for straight storage, head end and axle dynamo systems,

30 volts for straight storage and axle dynamo systems.

(12) That batteries shall be installed in double compartment tanks as per detail dimensions and design shown. (Not reproduced.)

The committee also desires to offer the several suggestions relative to changes in the Master Car Builders' rules covering the interchange of equipment, which suggestions have been forwarded to the Arbitration Committee through the Secretary.

Discussion—The privilege of the floor was extended to Mr. Cartwright, electrical engineer of the Lehigh Valley, who criticised the report at some length, particularly where it differed from recommendations of the Association of Railway Electrical Engineers.

Mr. Wilden thought that the depreciation of 75 cents per day for batteries was too high.

Action—Report accepted and committee continued.

CAR FRAMING, ROOFS AND DOORS.

Committee:—W. F. Bentley, Chairman; J. A. McRae, R. S. Miller, C. F. Thiele, G. W. Lillie.

From investigations made in yards by the committee as a whole, as well as those made by individual members, also from recommendations and drawings submitted, we found a rapid change taking place in the detailing of each of the three subjects in question, at the same time, each subject apparently handled or detailed by the different designers from a different basis as a guide; therefore, after carefully considering, we recommend the following on each subject, and that each recommendation be considered as the minimum basis for future development.

THE CONSTRUCTION OF CAR ROOFS

That the most durable and economical roof for use is an outside metal roof of good quality of steel or wrought-iron sheets, with a minimum weight per square foot of 14 ounces, thoroughly and evenly galvanized with a minimum coating of zinc of 1½ ounces per square foot, and provided with flexible joints. Roof supported by a construction to carry at a safety factor of five, a uniformly distributed load of not less than 360 pounds per running foot of length of car.

The carlines should be metal, so constructed in connection with purlins running lengthwise, and roof boards running crosswise of car, to provide proper tie and bracing to side and end framing at roof line.

We recommend that the above details be submitted to letter ballot, with a view of adopting as minimum requirements for Recommended Practice of the M. C. B. Association.

Our reasons for the above are, that inside metal roofs are causing considerable trouble after every effort to get a strong roof construction, and after paying a very fair price for lumber entering into such a construction, nevertheless can not be held intact, on account of lumber splitting, shrinking, warping and decaying; also due to nails breaking, rusting or enlarging of nail holes, thereby failing to hold purlins or other parts, and permitting roof sheets or roofing boards to shift, lift off or slide out of place, and with certain forms of construction the entire roof has been known to lift off, thus causing leaks, and in so sliding are liable to strike and rake passing trains; further, the metal inside sheets, which are mostly concealed, crack and rust out in time, causing leaks that can only be located with difficulty and considerable expense.

The double board and inside plastic, and similarly constructed roofs, have short life, due to decay and inability to hold intact for reasons stated above.

We understand one railroad is applying, experimentally, a number of steel-riveted roofs made of plates about .1 of an inch in thickness; further, that there are on the market steel roofs and carlines, with the roof sheets removable and of heavy-gauge steel plates, which later construction of roof sheets provide flexibility.

END BRACING FOR BOX CARS

That the minimum end construction for the box car of wood superstructure and of American Railway Association dimensions be provided with oak center end posts, 5 by 5, and oak braces, 5 by 5, or material of equal strength, substantially secured at each end through the medium of very substantial pocket castings, properly lipped, to prevent shifting by strains due to ordinary shifting of any lading from within, at the same time car provided with end plate, equal to 4¼-inch Y pins in thickness, the end plate as well as belt rail, or rails, strapped or very securely tied to side plate and side belt rails respectively. The end lining to be 1¾

inches in thickness and extend from about 1 inch above lower edge of end plate to within 3 inches from floor or subsill on cars so provided.

The lining at upper edge of belt rail, or rails, to clear same by ½ inch, to permit grain getting between lining and siding to fall into car as grain is unloaded; further, that at points where braces and posts meet near the bottom, openings be provided in the lining to permit grain and other similar lading getting between lining and siding below belt rail, or rails, to fall into car as contents are unloaded.

At the floor line where lining comes to within 3 inches of floor level or subsill on cars so provided, bevel strip measuring 3 inches on the square sides must be neatly and closely fitted and secured to floor between posts and braces to prevent grain pressure acting on inside of siding and forcing it outward; this to prevent grain leakage.

The end construction, including floor, as well as floor at side and door posts, also floor at draft bolts, must be very carefully fitted to prevent grain leakage at these points.

Care should be exercised in new construction and repairs to keep inside surfaces as free from projections as possible, so as to meet the requirements of the American Railway Association Rules and the Interstate Commerce Commission Regulations for the transportation of explosives, inflammable articles and acids.

In box-car construction with metal or part metal superstructure the end construction must be at least as strong as the minimum end construction of entire wood superstructure; further, the lining, flooring, bevel strips, etc., above specified, must be carefully carried out, and interior surfaces must be smooth, to prevent damaging of lading.

We recommend that the above details be submitted to letter ballot, with a view of adopting as a minimum requirement for Recommended Practice of the M. C. B. Association.

Our reasons for the above are, that the minimum dimensions for material as specified, with secure end pockets, also tieing, etc., are not excessively strong, and break in case of severe rough handling.

We are submitting for information of those interested a drawing, Fig. 1, which shows a method of end bracing in use on some cars, and which seems to have considerable merit and might be employed to advantage when repairing old equipment where it is considered the condition would justify.

BRACING FOR SIDE DOORS.

The outside-hung, side-sliding door, per drawing (not reproduced), also flush side door, per drawing (not reproduced), are to represent the minimum requirements in the door construction and details shown. Care should be exercised in selecting proper fixture details for use as part of the complete box-car side doors.

We recommend that the above, on bracing for side doors of box cars, including drawing herewith submitted, be submitted to letter ballot, with a view of adopting as Recommended Practice of the M. C. B. Association, and to supersede the Recommended Practice as included to date on this subject.

Our reasons for the above are, that side doors of box-car equipment are generally found in poor shape in many respects, and we feel that we cannot impress upon the members of this convention too strongly or forcibly the necessity of greater care being exercised in the design of new doors and the maintenance of existing doors and parts connected therewith. Passing trains are being scraped and other accidents are occurring by doors falling off or swinging out.

In the examination of many cars loaded and empty in various yards, the committee was very forcibly impressed with the fact

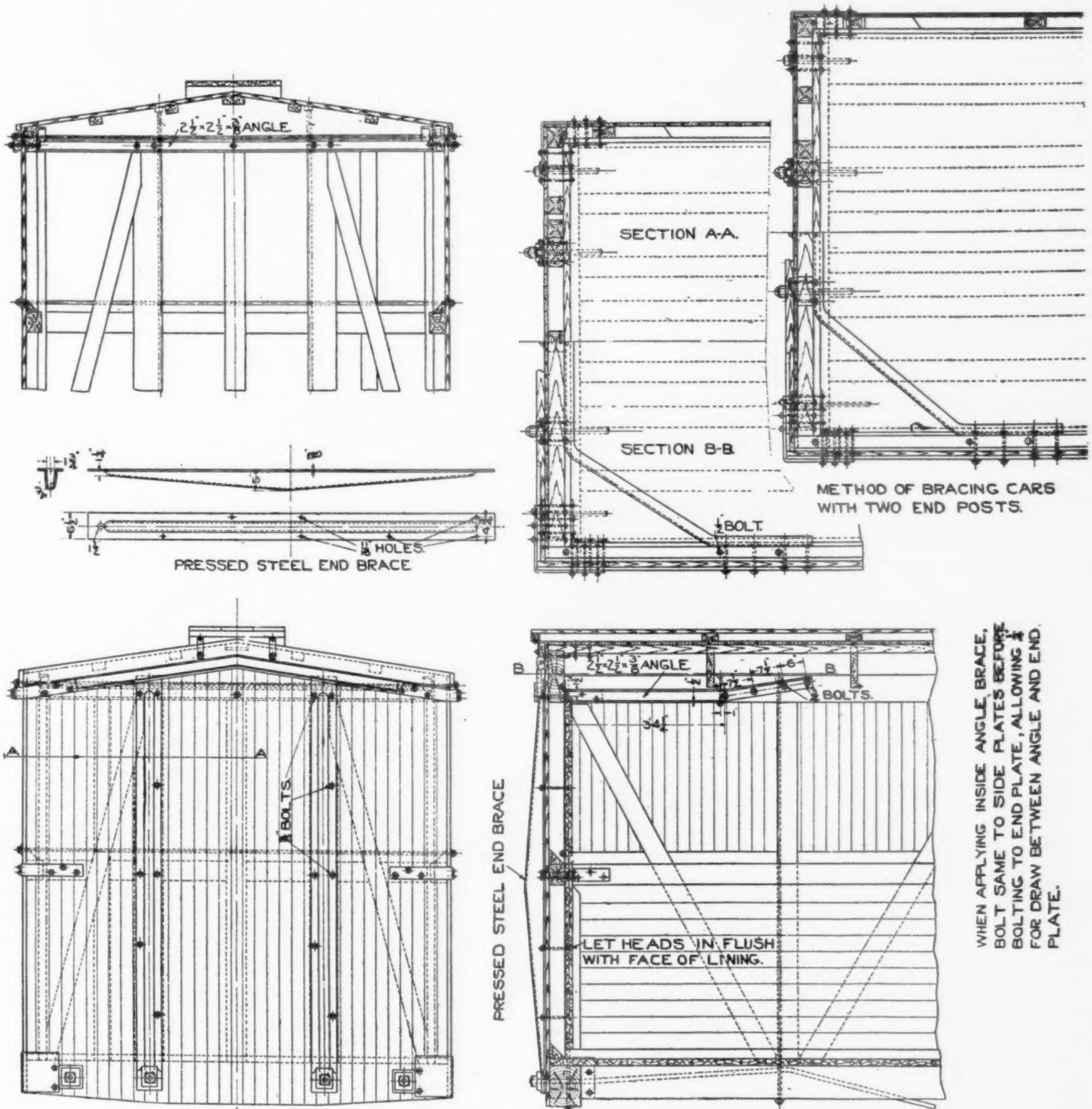


FIG. 1.—A METHOD OF END BRACING.

that door tracks, door hangers, door hasps, door-hasp keepers, door hoods and door-guide brackets are not being maintained in proper repair on existing cars, and in many cases doors were found worn or broken away at corners, to the extent that when doors were closed the door-guide brackets would not engage or hold doors at the bottom.

We further recommend that the door-hood coverings be omitted from new cars, and as much as possible in repairs to old cars, not only on account of becoming loose, but for the more important reason that they conceal and prevent proper inspection of the door tracks, door hangers and door rollers, thus preventing proper maintenance and menacing passing trains.

It will be noted on drawing for outside-hung sliding door, as submitted, that some modifications have been made since the same door was submitted for consideration at the 1909 convention, to meet criticisms made.

1. A lip has been added to the open door-stop, which is fastened to belt rail so as to better support the door from swinging out when in a full open position.

2. A note has been added to the drawing in substance as follows: "There must not be less than two bottom door-guide brackets supporting the door in any position, and not less than three bottom door-guide brackets supporting the door in the closed position." This note is added to emphasize the committee's location of bottom door-guide brackets, and we are satisfied, if closely followed, will overcome most of the trouble now experienced with outside doors swinging out.

3. A change has been made in the door handle, for the reason that men operating doors equipped with handles similar to the one on 1909 committee's drawing complained that door handles cut into gloves and hands.

4. Closed door wooden stop and stop brackets have been moved back a sufficient amount to give the door opening the full clearance provided for in the frame.

In considering the matter of flush car doors, the one that seems to be in most general use and which seems to give the most satisfaction is the Wagner car door substantially as shown in the M. C. B. 1896 Proceedings on page 286. Some changes have been made by lipping the upper door operating rod slides over the top rail and increasing the rabbet at sides of door from 7/8 to 1½ inches.

The men at freight houses who operate these doors claim they open more easily than outside-hung doors, because the first movement of car door is away from the load and car, while outside-hung sliding doors are frequently retarded in sliding by bulged sides, etc.

We know of no patents on the Wagner door and details as shown on drawing submitted.

We are also submitting, for information of those interested, prints showing general arrangements of "The Horn flush car door" (not reproduced), which several members of the committee had an opportunity to see operated on a car, but as patents are applied for on this device, prints are submitted without comment.

Discussion—Mr. Trimyer objected to the use of purlins and cross sheathing for metal roofs. His experience had indicated the use of longitudinal roof boards as preferable. He also thought 1¼ inch end lining was thick enough.

Mr. Seley also favored longitudinal roof boards, but favored the 1¾ inch end lining.

Mr. Hennessey did not favor the longitudinal roof boards. His experience was that the method recommended in the report was best.

Mr. Curtis thought that the details of some of the door fixtures and attachments should be shown more clearly.

Mr. Carr recommended the use of a Z bar for a door stop.

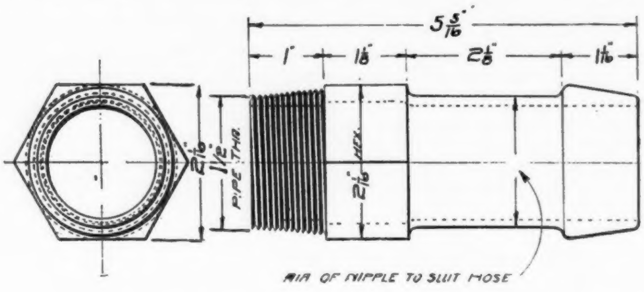
It was finally decided to refer only that part of the committee's report concerning the bracing of side doors to letter ballot. ballot.

TRAIN PIPE AND CONNECTIONS FOR STEAM HEAT.

Committee:—I. S. Downing, Chairman; H. E. Passmore, T. H. Russum, J. J. Ewing.

In considering this subject the committee decided to make tests to get a comparison between the large hose and couplings and medium hose and couplings. Tests were conducted at Collinwood on a train of thirteen cars, equipped with 2-inch pipe in the usual manner: Inlet controlling valves were all closed; steam was turned on at head end of train and time noted. When water appeared at the rear end the time was noted; when steam appeared the time was also noted. When steam appeared the valve on the rear end was closed. Time to get 10, 20, 30, 40, 50, 60 pounds in rear car was also noted.

From the data obtained, we find, of course, that the large coupling will allow steam to pass more freely than the medium, but the difference is not so great as to be of much consequence. We believe that either large or medium is entirely satisfactory. When the Master Car Builders adopted the large coupling and hose as Recommended Practice, in 1903, many prominent railroads immediately accepted the recommendation and put the large equipment on all of their passenger cars and passenger locomotives. On the other hand, there are many prominent railroads using the medium equipment, which is doing good work. Fortunately, however, the location of the roads using the large coupler is such that their passenger equipment seldom interchanges with the roads using the medium coupler; therefore, no difficulty whatever, so far as we can see, will ensue if the roads now using the large coupler continue its use, and the roads now using the



medium coupler continues its use. For this reason the committee does not recommend either for standard of the Association.

We do not recommend any end valve as standard at this time.

Recommendations.—1. Two-inch train line.

2. Location of steam train-line signal and brake pipe as shown on M. C. B. Sheet Q, with the following note: "The dimensions underscored should be maintained, but departure from other dimensions are allowable to suit conditions. Opening shown on steam line is the opening of train end valve."

3. End train-pipe valves.

4. Hose to be 31 inches from face of coupler gasket to end of nipple.

5. Nipple on coupler to be 20 degrees minimum and 25 degrees maximum angle with horizontal.

6. Nipple as shown in the illustration.

It seemed to be the consensus of opinion that a standard steam heat hose should be adopted and a motion was carried providing that the committee be continued and instructed to prepare standard dimensions and also specifications for steam heat hose.

MOUNTING PRESSURES FOR VARIOUS SIZES OF AXLES AND KINDS OF WHEELS.

Committee:—E. D. Nelson, A. Forsyth, W. T. Gorrell, J. F. Walsh, W. P. Richardson.

To specify certain mounting pressures for wheels and not specify the greater workmanship in boring the wheels and turning the wheel seats of the axles, would be only incomplete information.

A very careful study has been made in one of the larger railroad shops, covering the entire operation of machining and mounting wheels and axles, with the idea of improving the work, and, if possible, reducing the cost.

It developed that proper mounting of wheels depends on the grade of workmanship in turning the wheel seats and boring the wheels.

It has further been demonstrated that the work can be done properly without any additional cost over a lower grade of workmanship and with the same grade of men as ordinarily employed. The men employed on this class of work usually become experts and can, if properly instructed, turn out work of the best character.

It is important to consider that good work cannot be performed without good tools. Proper shop practice will not permit lathes and boring mills to get in bad repair. Lathe centers out of line or the V's worn may allow an axle to be turned tapered, while lathes in proper repair will insure wheel seats being turned straight. A tapered wheel seat with the wheel bored straight cannot be expected to make a proper fit at any mounting pressure.

A very satisfactory test for lathes is to take two or three light cuts from an axle wheel seat, say seven inches long, and measure the diameters with micrometer calipers. Good practice indicates that there should not be a variation in diameter exceeding two one-thousandths (.002") of an inch. The same attention given to lathes should be extended also to boring mills to see that they are in proper condition to turn out good work.

The general tendency has been to finish axles with too rough a wheel seat, which results from too coarse a feed. This makes only partial contact between the wheel seat and axle. While axles may hold satisfactorily under these conditions, there is always an element of uncertainty, which can be eliminated by better prac-

tice. The axle, roughly turned in this way, cannot be accurately calipered, and this is the essential to good fitting and security. Furthermore, in mounting the wheel, the high ridges obtained with a roughly turned wheel seat are pushed off, principally at the outer end of the axle, reducing its diameter and making the turning of the wheel seat necessary when preparing the axle for mounting wheels at a later time. There is, also, a bad moral effect on men, who, if permitted to carry out this practice, will extend it to journals as well.

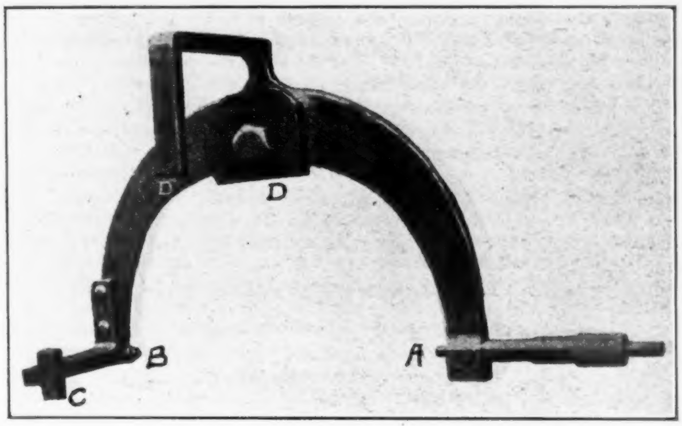


FIG. 1.

It has been demonstrated that with fairly rigid lathes axles can be turned at a speed of forty to fifty revolutions per minute, the limit of speed being the chattering of the tool rather than the cutting speed. With this high speed run with a fine feed, an axle can be turned in about the same time as by slow speeds and coarser feed. The higher speed results in better work without increased cost.

Having secured straight and true wheel seats and wheel bores, the next necessity is for the proper diameters necessary in secure mounting.

Micrometer calipers are necessary for several reasons. The axles and wheels can be calipered more quickly and more accurately than by machinist's calipers or snap gauges. The "draw" or difference in diameter of wheel seat and bore which has been determined for a proper fit, can be secured without difficulty. The difference between diameters of wheel seat and bore of wheel expressed in thousandths of an inch, can be measured accurately, whereas with ordinary calipers it is a question of skill of the workman and with snap gauges the same is true to a lesser degree.

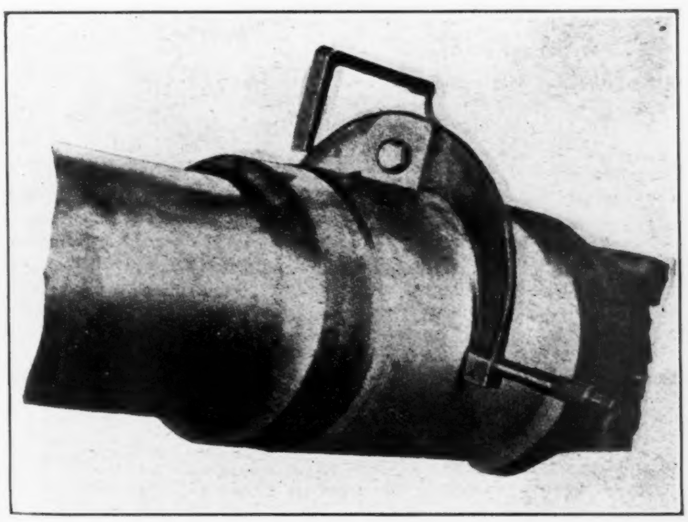


FIG. 2.

For shop inspection, certain limits can be set between which the axle or wheel may vary and be good enough for all requirements. The inspector having set limits is not permitted to use judgment, which is always liable to error; if the work is within the limits he must pass it.

If not, it must go back to the man who did the work, and he, knowing his work must meet certain definite requirements determined by the proper measuring instrument, naturally endeavors to turn out good work rather than take the chance of doing it over without pay.

To successfully use, for wheels and axles, the ordinary trade micrometer caliper, takes time and a certain amount of skill. To reduce his time and skill to the minimum, micrometer calipers have been designed and used successfully. Fig. 1 shows a photograph of caliper for wheel seats. "A" is an ordinary micrometer

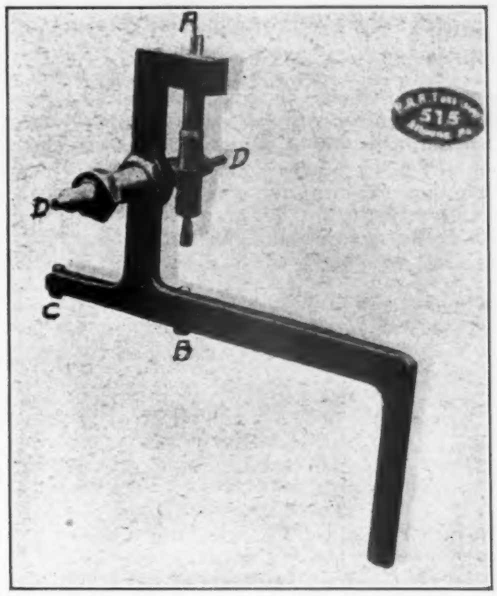


FIG. 3.

head that can be bought in the open market; "B" is the anvil; "C" is a stop set square with a line through "A" and "B"; "D" is a stop or limit which may be turned, so that the distance from the stop to the line from "A" to "B" shall be approximately the radius of the wheel seat. In practice, this stop "D" for the 5½ in. by 10 in. journal axles is correct for wheel seats 6⅞ in. in diameter, and is approximately correct for wheel seats from 6¾ in. to 7 in. By turning the stop "D" one-quarter turn, it is suitable for 5 x 9 in. journals.

In using this caliper it is placed over the axle, with stop "D" resting on the wheel seat, as shown in Fig. 2. The stop "C" and anvil "B" are then brought firm against the wheel seat. The micrometer is screwed up by a ratchet stop until the ratchet clicks. The caliper is then removed and read. On a trial, eight axles were measured in five minutes and twelve wheels were measured in the same space of time. Each wheel seat was measured at three points, the average taken and size chalked on the

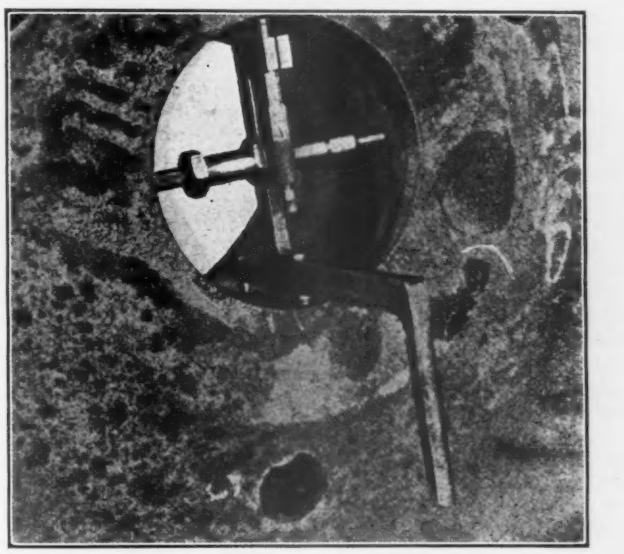


FIG. 4.

axle. The wheel seats had not been previously measured and but few were of the same size. This is much more rapid than calipering by other means, especially for axles varying in diameter.

Fig. 3 illustrates a caliper for wheel bore. "A" is the micrometer head, but graduated for internal measurement; "B" is the anvil; "C" the stop, set at right angles to a line from "A" to "B"; "DD" are right and left hand screws, turning together by means of a link not shown.

In calipering a wheel the screws "DD" are roughtly adjusted

somewhat smaller than the bore of the wheel. The anvil "B" and stop "C" are brought against the bore and micrometer screwed out until the ratchet clicks. (See Fig. 4.) On a trial five wheels were calipered and size chalked on wheel in five minutes.

The measuring was done by an apprentice, who was able to do it in an entirely satisfactory manner after about one hour's instruction.

This method of calipering and marking each wheel seat with the points and the further calipering of the bored wheels with the sizes marked upon them, permits the proper selection of wheels at wheel seats for mounting, in order to secure the pressures necessary.

As to mounting pressures, the committee recommends the following, in conjunction with the character of workmanship already referred to, as being an essential in the problem:

WHEELS

M. C. B. Axle	Size of Journal	Cast Iron (Tons) Maximum	Cast Iron (Tons) Minimum	Steel (Tons) Maximum	Steel (Tons) Minimum
A	3¾ in. x 7 in.	44	36	66	54
B	4¼ in. x 8 in.	44	36	66	54
C	5 in. x 9 in.	55	45	83	68
D	5½ in. x 10 in.	55	45	83	68

The following general specifications, which have been quite thoroughly tested, are submitted for consideration.

AXLE WHEEL FIT.

Must be turned as smooth as possible with lathe tool having flat cutting edge. Finishing cut must not be taken with lathe feed coarser than 16 pitch. Taper on axle wheel seat for entering wheel must not exceed one-half inch in length and must be turned with broad, straight faced tool, making regular taper without ridges or rings. Wheel fits to be calipered at three points, namely:

One inch from each end and middle and other points of indications point to excessive variations in diameter.

Axles should be considered as suitable for mounting where there is a difference in diameter between any two measurements exceeding .003 of an inch. This, however, should not be construed to mean that wheel seats on each end of axle are to be of one size. Each tenth axle from each lathe shall be measured for soundness. No axle varying over .001 of an inch when measured at two points ninety degrees apart on circumference at equal distance from end shall be considered as suitable for mounting.

WHEELS.

To be bored smooth. Finishing cut shall be made with tool or tools having a cutting face at least 3-16 of an inch wide. Feed not to exceed 8 pitch. To be bored with a rough and finishing cut. The finishing cutter when taking the finishing cut must not be cutting when roughing tool is also rough-boring, unless the finishing tool is supported independent of roughing tool, the latter to prevent spring of roughing tool being transmitted to finish tool, causing an irregular bore.

Wheels to be calipered with micrometer caliper. A wheel varying over .002 of an inch in any two diameters will not be considered satisfactory for mounting.

Mounting presses to be provided with recording pressure gauges. All wheels not mounted within limits given, or wheels that are forced against shoulder, to be withdrawn.

One point that may be foreign to the subject should receive attention, which is lathe centers. It would be very desirable if all shops were to adopt one angle. Generally, lathe centers used for ordinary work are sixty degrees, including angle. If this were adopted for all axle work, it would result in the axles running true on centers, reducing the amount of material necessary to turn away when truing up axles that have been previously turned.

Discussion—Mr. Vaughan criticised the report in that it only specified maximum and minimum mounting pressures. He felt that any specification for mounting wheels should include the pressure when the wheel is partly pressed on.

Mr. Curtis believed the report should specify that the ton mentioned was a net ton.

Action—The report was accepted and ordered to be printed in the proceedings.

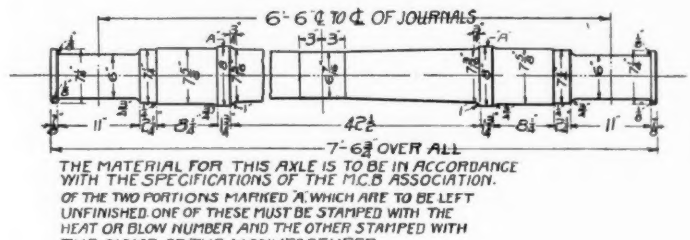
DESIGN OF FREIGHT-CAR AXLE TO CARRY A LOAD OF 50,000 POUNDS.

By E. D. Nelson.

During the past year it has come to my attention that there are at least four railroad companies, represented in the Master Car Builders' Association, which have had under consideration a car axle of a larger capacity than the Standard "D" axle of this Association. As a matter of fact, there have been designs made of axles of larger capacity, and naturally these differ somewhat in detail.

The importance of eliminating variations in design is apparent, and I have, therefore, considered it advisable to present a design of axle having a capacity of 50,000 pounds, with a view to its consideration at the present convention.

If the Association would, after consideration, recommend that the adoption of this design as Recommended Practice for one year be submitted to letter ballot, it would give an opportunity to establish a design which could be followed by any



PROPOSED "E" AXLE, M. C. B.

railroad company during the coming year and prevent axles of larger capacity than the "D" axle and, varying in detail, getting into service.

In submitting this design of axle of 50,000 pounds capacity, the method outlined in the report of the Committee on Axle, Journal Box, Bearing and Wedge, made to the convention of 1896, has been followed. The method outlined at that time is applicable to axles of any capacity, so far as our present knowledge is concerned. The assumed data are as follows:

Weight of body and trucks	55,580 lbs.	
Weight of lading	140,000 "	
10 per cent. additional lading	14,000 "	
Total		209,580 lbs.
Deduct weight of 8 33-inch forged steel wheels	5,720 "	
Deduct weight of 4 axles	3,860 "	
Total		9,580 "
Total weight on four axles		200,000 "
Total weight on one axle		50,000 "

Assuming for this load that the journal should be 11 inches long, its diameter should be, according to (Formula 5), page 152, and by substitution in (Formula 12), page 153, M. C. B. Proceedings of 1896, 5.38 inches. Taking the nearest ⅛ of an inch above this makes the diameter 5½ inches, and an allowance of ½-inch diameter for wear brings the diameter of the journal, when new, to 6 inches.

Assuming then, that the journal is 6 inches in diameter by 11 inches long, the consideration so far as friction and lubrication are concerned, would be, quoting the figures from page 169 of the Proceedings of the Association of 1896, as follows:

4¼ by 8 inch journal, new, pressure per square inch..449 pounds
5 by 9 inch journal, new, pressure per square inch..469 pounds
5½ by 10 inch journal, new, pressure per square inch..470 pounds
6 by 11 inch journal, new, pressure per square inch..503 pounds
4½ by 8 inch journal, old, pressure per square inch...533 pounds
5 by 9 inch journal, old, pressure per square inch...525 pounds
5½ by 10 inch journal, old, pressure per square inch...516 pounds
6 by 11 inch journal, old, pressure per square inch...549 pounds

These figures indicate that from the standpoint of friction and lubrication, satisfactory service may be expected from these journals.

Concerning the diameters of the axle at the wheel seat and center (Formula 10), page 152, and (Formula 12), page 153, of the Proceedings of 1896, give the following diameters:

Wheel seat ....7.40 inches
Center ....6.30 inches

For the wheel seat it has been customary to add ¼ of an inch to the calculated diameter, which would make the diameter at the wheel seat, when new, 7.650 inches. It has been customary, however, to keep the diameters at the wheel seat to the nearest ⅛ of an inch, and by making the diameter 7⅝ inches, ¼ of an inch diameter can be secured above the calculated diameter within 2½ one-hundredths of an inch, to the calculated diameter at the center, and an allowance must be made for the cylindrical portion of the axle, so that this portion does not change abruptly at its intersection with the taper portions of the axle. Taking the diameter to the nearest 1-16 of an inch, would make the diameter at the center 6 7-16 inches. The

principal dimensions, with the axle new, will, therefore, be as follows:

Journal, diameter	6 inches
Journal, length	11 inches
Wheel seat, diameter	7⅝ inches
Center, diameter	6 7-16 inches

The satisfactory results which have been obtained with former designs of axles of the M. C. B. Association, based on the formula as given in the report of 1896, seem to warrant the use of a fibre stress of 22,000 pounds per square inch as used for all of the previous M. C. B. axles, and this figure has been taken in the formulas in order to arrive at the diameters which have been given.

The attached drawing shows all the dimensions of the proposed axle. It has been designated in accordance with the former practice of the Association as Axle "E" and the quality of the material is to be the same as that required by the present M. C. B. Specifications.

Attention should be called to the fact that in the design of axle submitted, the distance between the dust-guard seats is 62½ inches, while in all of the other designs of axles of the Association it is 63 inches. In the design submitted, this ½ inch was taken off in order to get more clearance back of the journal box, and this will necessitate ¼ of an inch more dish in the wheels mounted on this design. While at first thought this may apparently indicate inability to interchange wheels between axles, it should be stated that the forged wheels with outside hub diameters suitable for the No. "D" axle, can probably not be bored out so as to fit the present design of axle and leave sufficient material in the hub. It will, therefore, mean that for the axle herewith submitted a special design of wheel will be required.

It is only necessary to add finally that, while the axle herewith submitted is nominally for a car having a capacity of 140,000 pounds, it must be understood that the axle is designed to carry a given load and the capacity of the car is only incidental. If a car body weighing less than that assumed above can be constructed, the decrease in the light weight can, of course, be added to the capacity. The point which should be emphasized is that the axle is designed to carry a load of 50,000 pounds and is not necessarily an axle suitable for a car of 140,000 pounds capacity, regardless of the weight of the car body on the trucks.

Discussion—It was explained by Mr. Kiesel that a special wheel would have to be designed to go with this axle anyway and that it would be possible to use the same wheel for 100,000 lb. capacity cars.

Mr. C. D. Young drew attention to the fact that this axle was but the start of a whole new truck.

Action—Referred to letter ballot for recommended practice.

LUMBER SPECIFICATIONS.

Committee:—American Ry. M. M. Assn.: R. E. Smith, J. F. DeVoy.

Committee:—Master Car Builders' Assn.: G. N. Dow, Chairman; G. H. Gilman, R. W. Burnett.

This matter has been thoroughly canvassed by committees of the Master Car Builders' Association, American Railway Master Mechanics' Association, the Railway Storekeepers' Association and the various lumber manufacturers' associations throughout the country. The specifications meet the approval of the various committees, and especially of the lumber manufacturers.

In order to have standard descriptions of the various woods used by railroads, the following standard names for car and locomotive lumber were agreed upon by the Joint Committee:

1. *Ash.*—To cover what is known as White Ash, Black Ash, Blue Ash, Green Ash and Red Ash.
2. *Basswood.*—To cover what is known as Linden, Linn, Lind or Lime-tree.
3. *Beech.*—To include Red or White Beech.
4. *Birch.*—To include Red, White, Yellow and Black Birch.
5. *Buckeye.*—To cover what is known as Horse Chestnut.
6. *Butternut.*—To cover wood from tree of that name, also known as White Walnut.
7. *Cherry.*—To include Sweet Cherry, Sour Cherry, Red Cherry, Black Cherry and Wild Cherry.
8. *Chestnut.*—To cover wood from tree of that name.
9. *Cottonwood.*—To cover wood from tree of that name. (Do not confuse with Popple or Poplar.)
10. *Cypress.*—To include Red Cypress, Gulf Cypress, Yellow and East Coast Cypress, also known as Bald Cypress.
11. *Elm—soft.*—To cover what is known as White Elm, Gray, Red and Winged Elm.
12. *Elm—rock.*—To cover what is known as Rock Elm.
13. *Douglas Fir.*—To cover Yellow Fir, Red Fir, Western Fir, Washington Fir, Oregon or Puget Sound Fir or Pine, Northwest and West Coast Fir.
14. *Gum.*—To cover what is known as Red Gum, Sweet Gum or Satin Walnut.
15. *Hemlock.*—To cover Southern or Eastern Hemlock; that is, Hemlock from all States east of and including Minnesota.
16. *Western Hemlock.*—To cover Hemlock from the Pacific Coast.
17. *Hickory.*—To include Shellbark, Kingnut, Mockernut, Pignut, Black, Shagbark and Bitternut.
18. *Western Larch.*—To cover species of Larch or Tamarack from the Rocky Mountain and Pacific Coast regions.
19. *Maple—soft.*—To include Soft and White Maple.
20. *Maple—hard.*—To cover what is known as Hard, Red, Rock and Sugar Maple.
21. *White Oak.*—To include White Oak, Burr Oak or Mossy Cup, Rock Oak, Post or Iron Oak, Overcup, Swamp Post, Live Oak, Chestnut Oak or Tan Bark, Yellow or Chinquapin Oak, Basket or Cow Oak.
22. *Red Oak.*—To include Red Oak, Pin Oak, Black Oak, Water Oak, Willow Oak, Spanish Oak, Scarlet Oak, Turkey Oak, Black Jack or Barn Oak, and Shingle or Laurel Oak.
23. *Pecan.*—To cover wood from tree of that name.
24. *Southern Yellow Pine.*—Under this heading two classes of timber are used: (a) Long-leaf Pine; (b) Short-leaf Pine. It is understood that these two terms are descriptive of quality rather than of botanical species; thus, Short-leaf Pine would cover such species as are known as North Carolina Pine, Loblolly Pine and Short-leaf Pine. Long-leaf Pine is descriptive of quality, and if Cuban, Short-leaf or Loblolly Pine is grown under such conditions that it produces a large percentage of hard summer wood, so as to be equivalent to the wood produced by the true Long-leaf, it would be covered by the term Long-leaf Pine.
25. *White Pine.*—To cover timber which has hitherto been known as White Pine, from Maine, Michigan, Canada, Wisconsin and Minnesota.
26. *Norway Pine.*—Also known as Red Pine, from Michigan, Minnesota, Wisconsin and Canada.
27. *Idaho White Pine.*—To cover variety of White Pine from western Montana, northern Idaho and eastern Washington.
28. *Western Pine.*—To cover timber known as White Pine coming from Arizona, California, New Mexico, Colorado, Oregon and Washington. This is the timber sometimes known as Western Yellow or Ponderosa Pine or California White Pine or Western White Pine.
29. *Poplar.*—To cover wood from the Tulip Tree, Whitewood, Yellow Poplar and Canary Wood.
30. *Redwood.*—To include the California wood usually known by that name.
31. *Spruce.*—To cover Eastern Spruce; that is, the Spruce timber coming from points east of and including Minnesota and Canada, including White, Red and Black Spruce.
32. *Western Spruce.*—To cover the Spruce timber from the Pacific Coast.
33. *Sycamore.*—To cover wood from tree of that name, otherwise known as Buttonwood.
34. *Tamarack.*—To cover timber known as Tamarack or Eastern Tamarack, from States east of and including Minnesota.
35. *Tupelo.*—Otherwise known as Tupelo Gum, Bay Poplar.
36. *Walnut.*—To cover Black Walnut (for White Walnut, see Butternut).

It is the opinion that the specifications which we have proposed cover nearly 95 per cent. of the lumber used in car and locomotive construction and maintenance, and the question of drawing specifications for the special hardwoods, such as mahogany and other imported lumber, was left open for further consideration.

RECOMMENDED CLASSIFICATION, GRADING AND DRESSING RULES FOR NORTHERN PINE CAR MATERIAL, INCLUDING WHITE AND NORWAY PINE AND EASTERN SPRUCE

[The committee here give detailed definitions of the various defects, including knots of all kinds, pitch, wane and sap, which, because of their length, are omitted.—ED.]

MISCELLANEOUS

Defects in rough stock caused by improper manufacture and drying will reduce grade unless they can be removed in dressing such stock to standard sizes.

All lumber for uses described in these rules shall be inspected on the face side to determine the grade, and the face side is the side showing the best quality or appearance.

Chipped grain consists in a part of the surface being chipped or broken out in small particles below the line of the cut, and as usually found should not be classed as torn grain, and shall not be considered a defect.

Torn grain consists in a part of the wood being torn out in the dressing. It occurs around knots and curly places, and is of four distinct characters; slight, medium, heavy and deep.

Slight torn grain shall not exceed 1-32 of an inch in depth, medium 1-16 of an inch, and heavy ⅛ of an inch. Any torn

grain heavier than 1/8 of an inch shall be termed deep.

The grade of all regular stock shall be determined by the number, character and position of the defects visible in any piece. The enumerated defects herein described admissible in any grade are intended to be descriptive of the coarsest pieces *such grades may contain,* but the average quality of the grade shall be midway between the highest and lowest pieces allowed in the grade.

Lumber and timber sawed for specific purposes must be inspected with a view to its adaptability for the use intended.

All dressed stock shall be measured strip count, viz.: full size of rough material necessarily used in its manufacture.

Lumber must be accepted on grade in the form in which it was shipped. Any subsequent change in manufacture or mill work will prohibit an inspection for the adjustment of claims, except with the consent of all parties interested.

The foregoing general observation shall apply to and govern the application of the following rules:

B and Better White Pine.—Material of this grade should be practically clear and free of all defects, except not exceeding three or four pin knots, and bright sap not to exceed 25 per cent. of the face of the piece.

C and Better Norway Pine.—Bright sap is no defect in this grade and stained sap will be admitted to the extent of not exceeding 1-5 the surface of the face of the piece, if not in combination with other defects. This grade should be free from shake, rot, splits, but will admit of three or four pin knots.

No. 1 Common White Pine, Norway Pine and Eastern Spruce.—This grade admits of small sound knots, but should be free from large or coarse knots, knotholes, should have practically no shake, wane or rot, but will admit of bright sap to any extent.

No. 2 Common White Pine, Norway Pine and Eastern Spruce.—This grade is similar to No. 1, described above, except that it will admit of spike knots, bright or stained sap, slight shake, slight wane on reverse side, but not a serious combination of any of these defects.

No. 3 Common White Pine, Norway Pine and Eastern Spruce.—This grade, in addition to the defects mentioned in No. 2 described above, will also admit of large or coarse knots, more shake, sap, wane on reverse side that does not affect the tongue or groove and torn or loosened grain, checks, pin wormholes or splits, but no loose knots or knotholes, nor a serious combination of the defects named.

No. 1 Common Norway Pine Car Decking or Flooring.—This grade will admit of sound knots, any amount of sap, and shall be free from shake, wane, rot or large, coarse spike knots.

Standard Lengths.—Car Siding: 8, 9, 10 and 12 feet or multiples. Car Roofing: 5 feet or multiples. Car Lining: 8, 9, 10, 12, 14, 16, 18 and 20 feet or multiples. Car Decking: 9 and 10 feet or multiples.

All orders shall be shipped in the standard length called for, unless otherwise specified, but no lengths of either car siding, lining or roofing shall be shipped except in the lengths specified or multiples thereof. Those who do not desire stock shipped in multiple lengths should so specify.

RECOMMENDED CLASSIFICATION GRADING AND DRESSING RULES FOR SOUTHERN YELLOW PINE CAR MATERIAL

[*Similar definitions of the defects mentioned under pine are omitted.*—ED.]

The foregoing general observation shall apply to and govern the application of the following rules:

B and Better Car Siding, Lining and Roofing will admit any two of the following, or their equivalent of combined defects: Sap stain not to exceed five per cent.; firm, red heart not to exceed fifteen per cent. of the face; three pin knots; one standard knot; three small pitch pockets; one standard pitch pocket; one standard pitch streak; slight torn grain, or small kiln or season checks. Where no other defects are contained, six small pin wormholes will be admitted.

Select Car Siding will admit of one standard pitch streak, one standard pitch pocket, or their equivalent; and, in addition, will admit of not exceeding fine pin knots and two standard knots, or their equivalent; ten per cent. sap stain; firm red heart; slight shake; heavy torn grain; defects in manufacture or seasoning checks. Pieces otherwise good enough for B, but containing a limited number of pin wormholes shall be graded *select.* This grade is intended to be accumulated from running B and Better stock, and will consist of all the droppings which do not contain defects in excess of those mentioned in this paragraph.

No. 1 Common Car Siding will admit of the following defects or their equivalent: Sound knots, not over one-half of cross section of the piece at any point throughout its width. Three pin knots or their equivalent. Wane 1/2 inch deep on edge not exceeding 1 1/2 inches wide and one-half the length of the piece. Torn grain; pitch pockets; pitch; sap stain; seasoning checks; slight shakes; firm red heart and a limited number of small wormholes well scattered.

This grade is intended to be worked from fencing stock, either kiln or air dried.

Select Car Lining and Roofing will admit of one standard pitch streak; one standard pitch pocket, or their equivalent, and, in addition, sound knots not over one-half the width of the piece in the rough; ten per cent. sap stain; firm red heart; slight shakes; heavy torn grain; defects in manufacture, or seasoning checks. Pieces otherwise good enough for B, but containing a limited number of pin wormholes shall be graded *select.* This grade is intended to be accumulated from running B and Better stock, and will consist of all the droppings which do not contain defects in excess of those mentioned in this paragraph.

No. 1 Common Car Lining and Roofing will admit of the following defects or their equivalent: Sound knots not over one-half the cross section of the piece at any point throughout its length; three pin knots or their equivalent; torn grain; pitch pockets; sap stains; seasoning checks; firm red heart, and a limited number of pin or small wormholes well scattered. This grade is intended to be worked from fencing stock, either kiln or air dried.

Standard Patterns.—(Insert B/P reference, showing net sizes after working.)

All-heart Car Decking or Flooring will admit sound knots not over one-third of the cross section of the piece at any point throughout its length, provided they are not in groups; pitch pockets; firm red heart; shake and seasoning checks which do not go through the piece; loose or heavy torn grain, or other machine defects, which will lay without waste or will not cause a leakage in cars when loaded with grain. Must be strictly *all heart* on both sides and both edges.

Heart Face Car Decking or Flooring will admit of sound knots not over one-third the cross section of the piece at any point throughout its length, provided they are not in groups; pitch pockets; firm red heart; shake and seasoning checks which do not go through the piece; loosened or heavy torn grain, or other machine defects, which will lay without waste, or will not cause a leakage in cars when loaded with grain. Will admit of any amount of sap provided all of the face side of the piece is strictly all heart.

No. 1 Common Car Decking or Flooring will admit of sound knots not over one-half the cross section of the piece at any point throughout its length, provided they are not in groups; pitch pockets; sap stain; firm red heart; shake and seasoning checks which do not go through the piece; a limited number of pin wormholes; loosened or heavy torn grain, or other machine defects, which lay without waste, or will not cause a leakage in cars when loaded with grain.

Standard Lengths.—Car Siding: 8, 9, 10 and 12 feet or multiples. Car Lining: 8, 9, 10, 12, 14, 16, 18 and 20 feet or multiples. Car Roofing: 5 feet or multiples. Car Decking or Flooring: 9 and 10 feet or multiples.

All orders shall be shipped in the standard lengths called for, unless otherwise specified, but no lengths of either car siding, lining or roofing shall be shipped, except in the lengths specified or multiples thereof. Those who do not desire stock shipped in multiple lengths should so specify.

CAR SILLS AND FRAMING

No. 1 Common Heart Car Sills and Framing will admit of sound knots, provided they are not in groups, the mean or average diameter of which shall not exceed two (2) inches; pitch; pitch pickets; slight shake; seasoning checks, or other defects which will not impair its strength more than the defects aforementioned. Must be sawed from sound timber, free from doty or rotten red heart and true to measurements, or at least the measurements at no point on the sill shall be less than the size required.

Measurement of the girth at any point throughout the length of the piece must show at least 75 per cent. heartwood.

Cubical contents shall not be used as basis for obtaining percentage of heartwood under this rule.

No. 1 Common Car Sills and Framing will admit of sound knots, provided they are not in groups, the mean or average diameter of which shall not exceed two (2) inches; pitch; pitch pockets; slight shake; seasoning checks; sap; sap stain, or other defects which will not impair its strength more than the defects aforementioned. Must be sawed true to measurements and from sound timber free from doty or rotten red heart; must be square cornered, except that one (1) inch of wane on one corner or one-half (1/2) inch of wane on two corners is admissible.

Sizes up to 6 inches in width shall measure full when green and not more than 1/8 inch scant when dry or part dry. Sizes 6 to 12 inches in width shall measure full when green and not more than 1/4 inch scant when dry or part dry. Sizes 12 to 16 inches in width shall measure full when green and not more than 3/8 inch scant when dry or part dry. Unless otherwise specified, one-fourth inch shall be allowed for each side which is to be dressed. Where stock is wanted dressed smooth all four sides, timber shall be sawed 1/2 inch full over the dressed sizes required. In pieces 3 by 6 inches and under when ordered in lengths exceeding 30 feet, sound knots shall not exceed one-quarter the width of the face through which they project, and the grain shall not cross sufficient to impair the strength.

RECOMMENDED CLASSIFICATION AND GRADING RULES FOR LOCOMOTIVES, FREIGHT AND PASSENGER CAR OAK

[*Definition of various defects omitted.*—ED.]

Locomotive Timber Oak. Passenger Car Dimension Oak. Refrigerator Car Dimension Oak.—Thickness cut to order, widths cut to order, lengths cut to order. Unless otherwise noted, must be cut from white oak. This stock, wherever practical, should be cut outside the heart and must be free of heart shake in pieces under 6 by 6 square. No attempt should be made to box the heart in pieces smaller than 5 by 7, unless heart is very small and tight. When heart is well boxed it must be firm and tight, and the center of the heart must not be nearer than 2 inches from any face. Must be sawed full to sizes with square edges, and cut from sound timber and free from wormholes, with the exception of a few small pin wormholes well scattered, and an occasional spot worm. None of these defects, however, to affect the serviceability of the piece for the purpose intended. Must be free from split, rot or dote, large, loose, rotten or unsound knots, or, in other words, free of all defects affecting the strength and durability of the piece. Sound standard knots well scatttered not considered a defect.

Freight Car Timbers.—Freight car dimension, including all cars other than refrigerator and passenger car. Sizes cut to order. Unless otherwise ordered, must be sawed from good merchantable white or red oak timber. This stock must be free of rot, shakes and splits, large, loose, rotten or unsound knots, any of which will materially impair the strength and durability of the piece for the purpose intended. This stock is intended to work full size and length without waste for side posts, braces and end sills, end plates, drafting timbers, cross ties, etc., used in the construction of ordinary freight or stock cars. On pieces 3 by 4 inches or equivalent girth measure and larger (nothing under 2 inches thick), heart check showing on one corner, admitted on twenty per cent. of the pieces in each car shipment. Well-boxed, sound hearts admitted in this material in pieces 5 by 6 and larger.

On pieces 3 by 4 to 6 by 6, inclusive, or equivalent girth measure and larger (nothing under 2 inches thick), in absence of heart defects, wane on one corner, ¾ inch side measurement, admitted on not to exceed twenty per cent. of the number of pieces in each car shipment.

Pieces over 6 by 6 square may contain 1 inch wane, side measurement, on one corner, with other conditions same as 3 by 4 to 6 by 6 sizes.

RECOMMENDED CLASSIFICATION AND GRADING RULES FOR DOUGLAS FIR CAR AND LOCOMOTIVE MATERIAL.

[*Definition of various defects omitted.*—ED.]

The term "Edge Grain" is here used as synonymous with vertical grain, rift-sawn, or quarter-sawed. The term "Flat Grain" is synonymous with slash grain or plain sawed.

No. 2 Clear and Better Edge Grain.—Material of this grade shall be well manufactured with angle of grain not less than forty-five degrees. This stock shall be kiln-dried and practically free from all defects, but will admit of bright sap on the face; not exceeding three small close pitch pockets not over 2 inches long, one pin knot, slight roughness in dressing, but not a serious combination of these defects.

No 2 Clear and Better Flat Grain.—Material of this grade shall be well manufactured. The stock shall be kiln-dried and practically free from all defects, but will admit of bright sap on the face; not exceeding three small close pitch pockets not over 2 inches long, one pin knot, slight roughness in dressing, but not a serious combination of these defects.

No. 3 Clear.—Material of this grade should be sound common lumber and will admit of roughness in dressing, bright sap, and also may contain five pin, three small and one standard knot and five pitch pockets in any continuous 5 feet of length of the piece; or any combination of tight knots or pitch pockets equivalent to those mentioned above. This grade particularly refers to stock used for inside lining of freight cars.

Standard Car Decking or Flooring.—Stock in this grade shall be well manufactured from sound live timber and shall be free from splits, shakes, rot, bark or waney edges, and unsound knots, or pitch pockets, pitch seams or large knots which would weaken the piece for the use intended. This grade will admit of sound knots not to exceed one-third width of the piece, provided they are not in clusters, and sap.

Common Car Sills and Framing.—Stock in this grade shall be well manufactured from sound live timber, sawed full size to sizes ordered and free from rot, unsound knots, cross grain, bark or waney edges or shakes, but will admit of sap and any number of sound knots, provided they are not in clusters, and do not exceed one-third width of piece; pitch pockets or pitch seams that would not weaken the piece for the purpose intended.

Sizes up to 6 inches in width shall measure full when green, and not more than ⅛ inch scant when dry or part dry. Sizes 6 to 12 inches in width shall measure full when green and not more than ¼ inch scant when dry or part dry. Sizes 12 to 16 inches in width shall measure full when green and not more than ⅜ inch scant when dry or part dry. Unless otherwise specified, ¼ inch shall be allowed for each side which is to be dressed. Where stock is wanted dressed smooth all four sides, timber shall be sawed ½ inch full over the dressed sizes required. In pieces 3 by 6 inches and under when ordered in lengths exceeding 30 feet, sound knots shall not exceed one-quarter the width of the face through which they project, and the grain shall not cross sufficient to impair the strength.

Standard Lengths.—Car Siding: 8, 9, 10 and 12 feet or multiples. Car Roofing: 5 feet or multiples. Car Lining: 8, 9, 10, 12, 14, 16, 18 and 20 feet or multiples. Car Decking: 9 and 10 feet or multiples.

GRADING RULE FOR CYPRESS CAR ROOFING, SIDING OR LINING.

Material of this grade shall be well manufactured, and kiln-dried, and will admit of sound knots, any amount of stained sap; very small pin wormholes, such as will readily fill and cover by the usual painting; slight shake; a small split; ordinary season checks; but will not admit of grub wormholes, wane, knotholes, or defects which would prevent the use of each piece in its full width and length for the purpose intended as named above.

Standard Lengths.—Car Siding: 8, 9, 10 and 12 feet or multiples. Car Roofing: 5 feet or multiples. Car Lining: 8, 9, 14, 16, 18 and 20 feet or multiples.

Discussion—Mr. McCarthy, member of the committee on the same subject, from the Railway Storekeepers' Association, presented a number of slight changes that had been made since the report was printed.

Action—Referred in its corrected form to letter ballot for recommended practice. Committee continued.

SPRINGS FOR FREIGHT CAR TRUCKS.

The committee asked for more time in which to prepare a report. This was granted.

CAR WHEELS.

Committee:—Wm. Garstang, Chairman, A. E. Manchester, O. C. Cromwell, W. C. A. Henry, R. W. Burnett, A. Kearney, R. L. Ettenger.

At the last convention revised drawings for the flange and tread contour of all wheels and a revised design for the 625-pound wheel with corrected specifications covering the three wheels were presented.

The committee has held several meetings during the year. two of them being joint meetings with the car-wheel manufacturers, and from the reports of the manufacturers and what we have heard from other lines, the indications are that a larger number of roads have adopted the new 1909 wheel than have previously purchased wheels made to the M. C. B. design. We learned from the manufacturers that they are rapidly getting in position to furnish the new wheel with the revised tread and flange, and that their orders justify making the change as rapidly as possible.

In view of the fact that the 1909 wheel has been so favorably received and that nothing has occurred to justify considering a change in the design, the committee has no recommendations to make covering the wheels or specifications.

We have received some communications during the year requiring attention, which have been handled as follows:

Attention has been called to the maximum flange thickness gauge, Sheet M. C. B.—16, not showing sufficient dimensions to accurately lay out the gauge. To correct this, a new drawing of the gauge, which is not changed, but has additional dimensions is presented.

The committee finds that there is no maximum allowable height of flange specified for cast-iron wheels, so as not to damage track crossings and frog filling blocks, and would recommend for this dimension 1½ inches, which is the same as has already been adopted for steel and steel-tired wheels, as shown in cuts on pages 98, 99, 100 and 101 in the 1909 Interchange Rules.

The attention of the committee has been called to the fact that brackets used on existing wheel circumference measuring tapes were made to conform to M. C. B. Standard tread and flange contour prior to modification of the 1907 convention, and it is the recommendation of the committee that these brackets be replaced with a form of bracket to suit the tread and flange contour adopted in 1909, and we enclose herewith drawing Fig. 2c. (not reproduced), showing the proposed new bracket, and recommend its adoption.

R. L. Kleine, chairman of the committee on standards and recommended practice, also forwards a letter relating to the

diameter of new all-steel or steel-tired wheels, and the limit in diameter to which they should be turned when used in freight service. This is an important matter, which affects the trucks, brakes, height of couplers and interchange bills to an extent that the wheel committee feel is out of their jurisdiction, and suggest that it be handled by a special committee.

We have a communication from the Wheel Manufacturers' Association, which has been under consideration for several months, but can not recommend to the Association the adoption of the suggestions made, as we feel that it is unnecessary to have as a standard of the Association a special wheel weighing 675 pounds for exclusive use under 60,000-pound refrigerator cars when the 675-pound 80,000-pound capacity wheel, by a slight change in the core, can be used. The Manufacturers' Association also ask a modification of the present test requirements, which the committee can not see its way clear to recommend.

Discussion—Mr. Gibbs drew attention to the fact that the committee had not made any recommendation for limiting the variation in diameter. He considered this to be of pressing importance and believed the committee could easily handle it.

Mr. Cromwell explained that the committee had considered this matter late in the season and felt that it was of too much importance to be decided in so short a time. The president explained to Mr. Gibbs that the executive committee would take care of this subject by means of either another committee or by referring it back to this one.

The report was received and submitted to letter ballot.

DANGEROUS OXY-ACETYLENE APPARATUS

To the Editor:—

Believing that you are desirous of informing your readers correctly, concerning the bad practices which are resulting disastrously to the oxy-acetylene industry, you are requested to publish the following communication. Realizing that some of your readers may possibly consider that the statements were inspired by a selfish interest, we invite a most searching investigation as to their correctness:

If the union of oxygen and acetylene did not produce an unusually powerful agent, the oxy-acetylene process would not have its present value. Acetylene is by far the richest of all gases in carbon, and combined with oxygen, produces much the hottest flame that has yet been created. It is generated from calcium carbide, which is nothing more than coke and lime combined at a very high temperature, but the finished product is as inert, and as little dengerous, as crushed stone, unless put in contact with water, and it can be subjected to any kind of rough usage without the least danger. Acetylene itself cannot be ignited without a mixture of air, or oxygen, unless it is compressed to more than thirty pounds pressure.

Chemically, oxygen is made from chlorate of potash, and similar materials, which are not dangerous unless placed in contact with carbonaceous matter, so that neither carbide, acetylene, nor the chemicals, are at all dangerous if they are properly handled; improperly treated, they can be made exceedingly dangerous, just as can ordinary coal, or water gas, or any of the hydro-carbons, such as gasoline, or oil.

The present acetylene generator is the evolution of various types that have been tested by years of use, and most of the earliest processes have been discarded by responsible manufacturers. Hundreds of thousands of acetylene generators are in use in the United States, and have become so important in the lighting industry, that they are the subject of yearly inspection by a body of engineers, in a laboratory which has been established by the National Board of Fire Underwriters. These engineers have become experts in the generation of acetylene, and have prescribed rules for the construction of such generators, which are the outcome of years of constant examination of apparatus of this character. Generators built in accordance with these rules, can be accepted by the public as desirable types.

These engineers, and the experience of a number of reputable manufacturers, have demonstrated beyond qeustion, that what is known as the carbide-to-water types, are most desirable for the generation of acetylene. Carbide has what is termed "endothermic heat," which is similar to the heat of lime, when slaking, only the heat is much greater. One pound of carbide will boil six pounds of water; consequently the engineers for the insurance underwriters have a rule, requiring one gallon of water for each pound of carbide, which, it will be apparent, is sufficient to insure cool generation.

The types generally discarded are known as the water-to-carbide generators. The methods employed in this type were to sprinkle water on the carbide, or to flood compartments, or were of the recession type, where the water rose to the carbide and was forced back by the gas generated when the water came into contact with the carbide. All of these types are objectionable, because there is not a sufficient supply of water present for proper chemical reaction, and it is entirely absent so far as cooling is concerned. The result is that more or less gas is polymerized, or turned into tar vapors, by the excessive heat evolved locally, making a poor gas; and with a rapid generation, there is danger of the heat becoming so great as to melt the portions of the generator in contact with the carbide, and to create danger of explosion should the generator be opened when the carbide is in this heated condition. Generally, the carbide is in the interior of the generator, surrounded by water, so that the heat is not perceptible from the outside of the generator, but it exists nevertheless.

Attracted by the supposed profits in the sale of oxy-acetylene apparatus, a new crop of generator makers, who are either unfamiliar with the established methods of generation, or unscrupulous, are springing into existence, and are placing these undesirable types on the market. They are doing exactly what was done with lighting generators, in the earlier part of their history, until there became a great class of what was known as "tin can" machines, the poor results from which it took years of strenuous efforts by the better class of makers to overcome. These types of generators are even more objectionable for oxy-acetylene welding, than they were for lighting purposes, because the gas consumption is much more rapid, multiplying the bad effects from this improper generation. Should such generators be subjected to the inspection of the insurance engineers, they would unquestionably be promptly rejected.

Bad as is this method of gas generation, a still worse condition exists. It is known to those who are at all familiar with acetylene, that when it is compressed to from 30 to 45 pounds, or more, there is a kind of disintegration of the molecules, causing the gas to be explosive in the presence of a spark. In the early history of the art, some terrific explosions occurred from compressing acetylene in this form, and for a time its use under compression was entirely abandoned. Through a French discovery it was learned that if cylinders were completely filled with a porous material, and this material was then saturated with acetone, the acetone would dissolve the gas to twenty-five times its own volume for each atmosphere of pressure, and that when the pressure was relieved the acetone would give off the acetylene, and that this method not only gave the cylinders a marvelous capacity, but made it entirely safe to use acetylene in this form. The "Presto-o-lite" cylinders, which can be found on almost any automobile, are examples of what has been done in this line, and many railroad cars are lighted by this system. It is also employed quite extensively in oxy-acetylene welding for portable uses.

In the face of past disastrous experience, there are persons who are manufacturing acetylene by compressing it direct from carbide, without purification, and during the past year there have been several fatal accidents from this cause. In one case nine people were killed, and the directors of the International Acetylene Association held a special meeting, and passed resolutions condemning this process, which is nothing less than criminal to employ.

A method is being used to make apparatus portable, which is nothing more or less than to place an acetylene generator on an ordinary truck, and wheel it about. A generator in this position is not only likely to be accidentally tipped from the truck, but it may be placed in close proximity to red-hot furnaces, or struck by swinging cranes, or injured in many other ways, and it does seem as though any careful, thoughtful person could immediately realize the danger of such an arrangement. If the generator should be tipped over, it would immediately bring the whole body of water and carbide into contact, which would certainly burst the generator, and the volume of gas released might come into contact with fire, and an explosion follow. Obvious as is this danger, there are men in important mechanical positions to whom it did not occur until their attention was called to the possibilities. Certainly, no intelligent insurance representative would approve of such apparatus.

So far from acetylene being considered dangerous, when properly manipulated, the highest insurance authorities have concluded that it is much safer than movable units, such as lamps; and there is no reason why it should not be equally safe for oxy-acetylene purposes.

The conditions with regard to the generation of oxygen, are not much better. The desire of many persons, who can use the oxy-acetylene welding process to advantage, to obtain apparatus at very low cost, has proved to be a great incentive to constructing the apparatus cheaply.

Oxygen has been produced in this country for many years from chlorate of potash, and similar chemicals, but in such cases it has been the practice of the most prominent manufacturers to generate this gas under only sufficient pressure to wash it thoroughly, and force it into a gasometer, from which it is compressed by a compressor into tanks for portable use.

It does not require much thought to realize that it would be much cheaper to generate the oxygen in the retorts, under sufficient pressure to force it into the tanks ready for use. This would cut out large washers, the gasometer, and the most expensive part of the plant, the compressor; such a plant could be built at small cost, and at considerable profit. That this is being done, and advertised quite extensively, requires only the examination of the advertising columns of a number of trade papers to show.

The most approved types of plants generating oxygen from chemicals, have the compressors built with two stages of compression, with an intercooling coil between the cylinders, and with the cylinders totally submerged in water, so that even though there are impurities in the gas, there is not sufficient heat generated to ignite the mixture. It is also required that the parts of these compressors subjected to oxygen, must be of non-corrosive metal, which adds still further to their cost. It will be evident that plants not having these necessary requisites, can be, and are sold, for much less than properly constructed apparatus.

Defective and dangerous types of oxy-acetylene apparatus have not, as a rule, given satisfactory results and tend to discredit the process. Such apparatus has injured the art not only in this country, but in Europe as well. Solicitations have been received by the company which the writer represents, to sell its apparatus in Austria, by a very prominent firm, whose letter states that that country has numerous cheap and ineffectiv plants, which have brought the process into disrepute.

AUGUSTINE DAVIS,
NEW YORK. President Davis-Bournonville Co.

UNIT SYSTEM OF ORGANIZATION ON THE UNION PACIFIC.

A circular issued by A. L. Mohler, general manager of the Union Pacific Railway, and approved by J. Kruttschnitt, director of maintenance and operation, announces the extension of the Hine unit system of organization to the general offices of the Union Pacific, and the former general superintendent, superintendent of motive power and machinery, chief engineer, superintendent of transportation, and assistant to the general manager have been appointed assistant general managers.

This system, as adopted in the general offices, is similar to that already in operation on most of the divisions of this railroad. The initial installation was made on the Nebraska division and the system and its purposes were fully outlined and described in a paper before the Western Railway Club by the originator, Major Charles Hine, which appeared on page 106, March, 1910, AMERICAN ENGINEER AND RAILROAD JOURNAL.

While at the time of its adoption it was regarded as an experiment it has worked out satisfactorily and will be further extended to all divisions as soon as details can be arranged. The general extension of the system, after about a year's trial, is an indication of its success and that it has become the fixed policy of the Harriman lines.

POSITIONS WANTED

ASSISTANT TO SUPERINTENDENT OF MOTIVE POWER OR GENERAL INSPECTOR.—Man with 20 years' railroad experience; technical education; has held all positions, from fireman to master mechanic, and from machinist to mechanical engineer; a hustler who can show results; is an expert on fuel tests, spark throwing, front end and draft arrangements.

SUPT. OF CONSTRUCTION, INSTALLATION ENGINEER, ENGINEERING SALESMAN, INSPECTOR.—Graduate in mechanical engineering, later special student in electrical engineering; over ten years' experience, East and West; railroad work, from shops to Assistant Engineer; experience with large engineering works and with consulting engineers. Preferred location, Pacific Northwest; installation, erecting, testing of machinery; steam or hydro-electric power plants, shops and mills, electric traction, irrigation pumping plants; some acquaintance with concrete.

BOOK NOTES.

Lubrication of Steam Engines. By T. C. Thomsen. Cloth. 5 by 7½. 97 pages. Illustrated. Published by The Technical Publishing Co., 55 Chancery Lane, W. C., London. Price, 60 cents.

This book confines itself principally to internal lubrication and goes very fully into a discussion of the chemical and physical properties of cylinder oils, the standard grade of oils and the different types of lubricators. It discusses the internal lubrication of all different types of steam engines using both saturated and superheated steam. One chapter is devoted particularly to locomotives. The dangers of the presence of cylinder oil in boiler feed water is discussed and oil separators are considered at some length. It is a very complete discussion of this important subject.

"Self Taught Mechanical Drawing and Elementary Machine Design." By F. L. Sylvester, M. E., and Erik Oberg. Cloth, 333 pages, 5 x 7¾ in. Illustrated. Published by the Norman W. Henley Pub .Co., 132 Nassau street, New York. Price, $2.00.

This is a very practical treatise on Mechanical Drawing and Machine Design, comprising the first principles of drawing, workshop mathematics, mechanism and the calculations and design of machine details. It is especially prepared for the practical mechanic and the young draftsman.

PERSONALS.

G. I. Evans, chief draftsman of the Canadian Pacific Railway at Montreal, Quebec, has been appointed mechanical engineer.

C. E. Fuller, superintendent of motive power and machinery on the Union Pacific Railroad, has been appointed assistant general manager under the new organization system.

Don B. Sebastian, acting fuel agent of the Chicago, Rock Island and Pacific Ry., has been appointed fuel agent, with headquarters at Chicago, Ill.

Walter E. Dunham, master mechanic of the Chicago and Northwestern Ry. at Winona, Minn., has been promoted to supervisor motive power and machinery, with offices at the same place.

J. D. Harris, general superintendent of motive power of the Baltimore & Ohio R. R. Co., with offices at Baltimore, Md., has had his authority extended over the Baltimore & Ohio Southwestern Railroad.

The office of master mechanic on the Chicago, Peoria & St. Louis Railway has been abolished and C. S. Branch has been appointed superintendent of the mechanical department, with office at Jacksonville, Ill.

J. F. Killeen has been appointed general mechanical foreman of the Washington division of the Oregon Railroad & Navigation Co., with office at Starbuck, Wash., succeeding M. J. Carrigan, resigned.

T. H. Goodnow, who was recently promoted to master mechanic of the Lake Shore and Michigan Southern Ry. at Elkhart, Ind., has resumed the former office of master car builder at Englewood, Ill., succeeding J. W. Senger, transferred.

Joseph Smith Harris, former president of the Philadelphia & Reading Railway, died suddenly on June 2, at his home in Germantown, Pa., from apoplexy. Mr. Harris was born in Chester

County, Pennsylvania, on April 29, 1836, and entered railway service in 1853, since which time he has been consecutively rodman and topographer, North Pennsylvania Railroad; in command of U. S. Steamer *Sachem*, attached to Farragut's Mississippi River Squadron; engineer of the Lehigh & Mahanoy Railroad; chief engineer Morris & Essex Railroad; chief engineer Philadelphia & Reading Coal & Iron Co.; superintendent and engineer Lehigh Coal & Navigation Co.; general manager Central Railroad of New Jersey; president Lehigh Coal & Navigation Co.; receiver and afterward vice-president of the Central Railroad of New Jersey; vice-president of the Philadelphia & Reading Railway; receiver and president Philadelphia & Reading Railway; president of the reorganized road, the Reading Co., Philadelphia & Reading Railway, and the Philadelphia & Reading Coal & Iron Co.

CATALOGS.

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

Pipe Unions.—The Jefferson Union Company, of Lexington, Mass., has recently prepared catalogs on their style F male and female unions and on their new swing union, which is practically universal. These will be sent on request.

Ball Bearing Line Shaft Hangers.—The Hess-Bright Mfg. Co., Philadelphia, Pa., is sending out sheets for their loose seaf binder on the above subject, giving dimensions of hangers for various loads.

Induction Motors.—The Sprague Electric Co., 527 West 34th St., New York, is sending out a large illustrated bulletin, No. 600, describing a variety of single and polyphase induction motors, including a number of efficiency curves and wiring diagrams.

Railroad Wrench.—The Uwanta Wrench Co., Meadville, Pa., has recently sent out a small circular describing the "Uwanta" wrench. This wrench is said to be a one-piece drop forging and very strong.

Friction Clutches.—A very artistic catalog describing and illustrating friction clutches for various purposes is being sent out by the Hill Clutch Co., Cleveland, O. These clutches have been in use for heavy work on elevating, conveying and cement machinery.

Conveying Machinery.—A new and complete catalog has recently been sent out by The C. W. Hunt Co., 45 Broadway, New York City, describing coal handling and hoisting machinery, conveyors and equipment for locomotive coaling stations.

Motor Inspection Cars.—The Buda Company, Chicago, is sending out an artistic and interesting catalog, which is well illustrated, showing their gasolene motor inspection cars for railroad work. These cars are made with a capacity for six passengers.

Pneumatic Hammers.—A new bulletin recently sent out by the Ingersoll Rand Company, 11 Broadway, New York, describes the imperial, type E pneumatic hammers, with sectional diagrams, showing the construction of these new tools.

Radial Drill.—The Mueller Machine Tool Co., Cincinnati, O., is issuing a number of new sheets for its loose leaf binder, with illustrations and description of their new standard radial drills, with 2½ to 4½ ft. arms.

Battery Charging Rheostats.—An interesting booklet of 42 pages with the above title has just been published by The Cutler-Hammer Mfg. Co., of Milwaukee. It describes this company's entire line of battery charging rheostats, comprising two types for charging ignition batteries and six types for general charging work, for electric pleasure vehicles and for trucks. Full page illustrations of the various types are shown besides several special types such as a motor-generator set panel and a panel for use with a gas engine driven dynamo and storage battery. The method of tabulating data and list prices is worthy of comment, all information being condensed into a single table.

Tungsten Lamps.—Bulletin No. 4739, just issued by the General Electric Company, Schenectady, N. Y., describes the "G.E." Mazda incandescent lamp, which has an improved tungsten filament and gives the high efficiency of 1 to 1¼ watts per candle power. In other words, the Mazda lamp divides the cost of current by three, or gives three times as much light for the same expenditure of energy. The bulletin describes this lamp in great detail, and illustrates the various sizes of this type of lamp for use on multiple circuits. It contains tables showing cost of operation and life, effect of voltage variation on candle-power and watts, relative costs of lighting with various lamps for equal illumination, etc., and also devotes considerable space to the reflectors necessary to give the best results.

NOTES.

Railway Supply Manufacturers' Association.—This association, with J. D. Conway as secretary, announces the removal of its offices from 313 Sixth avenue, to Room 2135, Oliver Bldg., Pittsburgh, Pa.

Falls Hollow Staybolt Co.—This company, of Cuyahoga Falls, O., advises that H. W. Davis, No. 2 Rector street, New York, has been appointed its Eastern representative.

B. F. Sturtevant Co.—It is announced by the above company that they inaugurated a new custom last June by holding their salesmen's convention at Hyde Park, Mass., at which the branch office managers and principal salesmen all over the country assembled.

Walter B. Snow, Publicity Engineer, Boston, Mass., announces that H. Ross Callaway, a graduate of the Massachusetts Institute of Technology, and late assistant to the mechanical engineer of the New York Edison Co., has been added to his staff.

Worcester Machine Screw Co.—The above company, of Worcester, Mass., announces the death of Edward Blake Dolliver, treasurer of the Standard Screw Company and manager of the Worcester Machine Screw Company.

Baldwin Locomotive Works.—Wm. L. Austin has been made president of the above company, succeeding John H. Converse, whose death was recently announced in these columns. Mr. Austin was formerly vice-president of the Baldwin Company and has been chief draftsman of the company for some time.

C. W. Hunt Company.—The above company, builders of coal handling, conveying and hoisting machinery, whose address is West New Brighton, N. Y., have opened offices in the State Bank Building, Richmond, Va., and also 607 Rhodes Building, Atlanta, Ga., in charge of W. F. Lee, for several years preliminary engineer to the company. C. T. Anderson has been appointed manager of the Chicago office, 1616 Fisher Building.

Detroit Seamless Steel Tubes Co.—This company announces the appointment of H. S. White as sales manager at Detroit, Mich. Mr. White's experience in the seamless tube field began in 1897 in the commercial department of the Pope Tube Co. in Hartford, Conn. From there he went to Cleveland as assistant general sales agent for the Shelby Steel Tube Co. at the time the former company was absorbed by the Shelby Tube Co. In 1903, after the absorption of this company by the National Tube Co., he became general manager of sales of the National Tube Co. in charge of the seamless steel product and was appointed to his present position on April 15, 1910.

Allis-Chalmers Company.—David Van Alstyne has been elected vice-president in charge of manufacturing of the above company, with headquarters at Milwaukee, Wis. Mr. Van Alstyne is specially well fitted for this work, and is one of the few men who understand thoroughly and know how to apply successfully, the principles underlying economical and efficient production on a large scale. He began work as a machinist on the Louisville & Nashville and was later master mechanic on the Louisville, Henderson & St. Louis Ry., superintendent of motive power on the Chicago Great Western RR. and mechanical superintendent on the Northern Pacific. His splendid work on these two roads attracted attention to his qualities as an executive and manager, and in 1907 he was elected vice-president in charge of manufacture of the American Locomotive Company. During the past few months he has been retained in a consulting capacity for a western railway system.

J. G. White Company.—It is announced that L. R. Pomeroy, who recently resigned the position of assistant to the president of the Safety Car Heating and Lighting Co., has been appointed chief engineer of the railway and industrial division of the above company in New York City. Mr. Pomeroy has for a long time been considered an authority on railway shop equipment, operation and construction, and is peculiarly adapted both by nature and training for his new work. Beginning in 1874 he was engaged successively in the commercial business; special auditing; drafting and designing of cars and locomotives. Then he was secretary and treasurer of the Suburban Rapid Transit Company of New York, and later a special representative of the Carnegie Steel Company and Cambria Steel Company, introducing basic boiler steel for locomotives and special forgings for railways. This assignment involved metallurgical engineering and experimental research to adapt special steels for railway axles, crank pins and piston rods. From 1899 to 1902 he was assistant general manager of the Schenectady Locomotive Works, and for six years following this he was a special representative in the railway field for the General Electric Company, this work covering the electrification of steam roads, railway shops and the general application of electricity for all railway purposes. For the past two years he has held the position with the Safety Car Heating and Lighting Company, which he resigned to take up his new work. While holding the last position, Mr. Pomeroy also devoted a portion of his time to consulting work in the special field of railway shops and machine tool operation.

ARTICULATED COMPOUND LOCOMOTIVES, 0-8-8-0 TYPE

NORFOLK AND WESTERN RAILWAY.

In addition to the five locomotives built by the Baldwin Locomotive Company, which were illustrated on page 269 of the July issue of this journal, the Norfolk & Western Railway is also receiving from the American Locomotive Company five engines of the same general type.

Inasmuch as great freedom was allowed the builders, in both of these orders, to use their own judgment as to general arrangement, and as both orders were built to cover practically the same specifications as to the work to be performed, the two designs illustrate the differences of opinion between the builders very clearly. The Baldwin locomotives are of the 2-8-8-2 type, having a total weight of 390,000 lbs., of which 360,000 is on drivers. The American locomotives are of the 0-8-8-0 type and weigh 375,000 lbs. total, all of which is on the drivers. Outside of this different wheel arrangement, the chief difference is found in the boiler construction. The fire box in both cases is practically the same, but in the Baldwin locomotives there are 350 2¼ in. tubes, 21 ft. long, which terminate in the combustion chamber, ahead of which is a feed water heater having 450 tubes 63 in. long and in the front end is a Baldwin superheater arranged as a reheater. The boiler is of the separable type, the joint coming at the combustion chamber. On the order here illustrated the boiler is simply and entirely a steam generator, having 367 2¼ in. flues, 24 ft. long, which end in the smoke box in the usual manner.

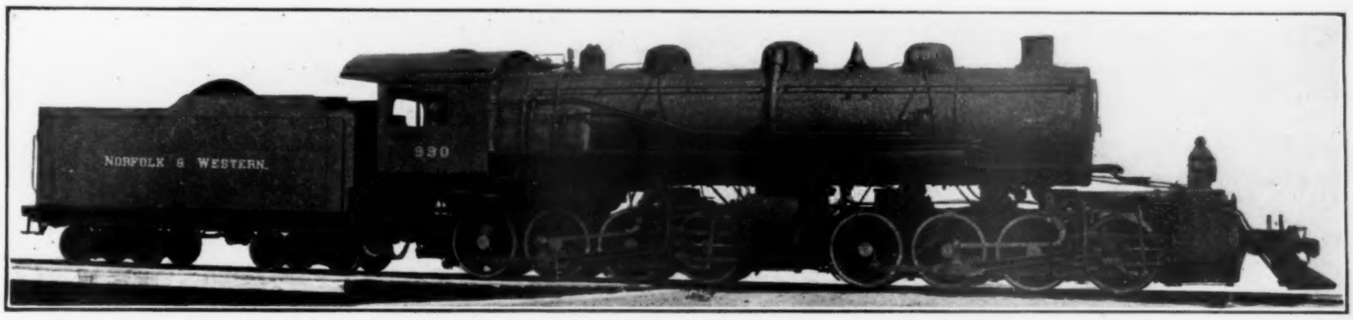
In the method of steam control is another noticeable difference. The Baldwin engines exhaust directly into the receiver pipe from the high pressure cylinders and provide simply a 1¼ inch pipe connection, with a globe valve in the cab, for furnishing steam to the low pressure cylinders in starting. This pipe connects to the receiver pipe, and its small size is depended upon to sufficiently reduce the pressure. The American locomotives are compounded on the Mellin system, which includes an automatic intercepting valve that admits steam at reduced pressure to the receiver as soon as the throttle is opened and automatically closes when the exhaust from the high pressure cylinders builds up the receiver pressure to the proper point. It can also be opened for the purpose of increasing the receiver pressure or "simpling" whenever desired.

These three features—*i. e.*, wheel arrangement, boiler construction and system of compounding—are the chief points wherein the two builders entertain different opinions, and an opportunity will be given the Norfolk & Western Railway to determine the relative value of the two arrangements, which it is hoped will assist in settling the differences of opinion which now seem to generally exist among railroad men as to the relative value of the two types.

These locomotives, while intended principally for use on the division between Columbus, O., and Roanoke, Va., a distance of 449 miles, on which there is a grade of 2 per cent. with some very sharp curves, will also be put into service, it is expected, on the main line between Norfolk and Bristol, a distance of about 408 miles, where a good opportunity is offered for obtaining the full advantages of the Mallet types, the grades on this section being from 1 to 1.3 per cent.

Referring to the locomotives built by the American Locomotive Co., the design is in general very similar to the enormous engines, six of which were recently delivered by these builders to the Delaware & Hudson Company, being illustrated on page 207 of the June issue of this journal. They are somewhat smaller than that design, however, and although the boiler tubes are the same length in each case, the Norfolk & Western locomotive does not have a combustion chamber. Also on account of the smaller boiler it was not necessary to follow the arrangement of steam piping required on the Delaware & Hudson engine and the high pressure steam is carried directly from the dome to the valve chamber in the usual manner.

A modification from the builder's former practice for articulated type of locomotives is found in the arrangement of the reversing connection to the low pressure engine, where a scheme similar to that on the Baldwin engines is used. This consists of carrying the connection between the high and low pressure reversing shafts between the frames, and providing it with a universal joint at the high pressure cylinders saddle. This arrangement eliminates the necessity of using universal joints in the radius bar hangers and does not give as great a disturbance in the valve elements when curving.



LOCOMOTIVE DESIGNED BY THE AMERICAN LOCOMOTIVE COMPANY FOR THE NORFOLK AND WESTERN RAILWAY.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	85,000 lbs.
Weight in working order	375,000 lbs.
Weight on drivers	375,000 lbs.
Weight of engine and tender in working order	433,600 lbs.
Wheel base, driving	15 ft. 6 in.
Wheel base, total	41 ft. 2 in.
Wheel base, engine and tender	72 ft. 10 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.42
Total weight ÷ tractive effort	4.42
Tractive effort × diam. drivers ÷ heating surface	887.00
Total heating surface ÷ grate area	71.00
Firebox heating surface ÷ total heating surface, %	3.95
Weight on drivers ÷ total heating surface	69.70
Volume equivalent simple cylinders, cu. ft	25.50
Total heating surface ÷ vol. equiv. cylinders	210.00
Grate area ÷ vol. equiv. cylinders	2.96
CYLINDERS.	
Kind	Compound
Diameter	24½ & 39 in.
Stroke	30 in.
VALVES.	
Kind, H. P.	14 in. Piston
Kind, L. P.	Slide
Greatest travel	6 in.
Outside lap, H. P.	1 in.
Outside lap, L. P.	⅞ in.

Inside clearance	3/16 in.
WHEELS.	
Driving, diameter over tires	56 in.
Driving, thickness of tires	3 in.
Driving journals, main, diameter and length	10 x 12 in.
Driving journals, others, diameter and length	9½ x 12 in.
BOILER.	
Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	83⅞ in.
Firebox, length and width	120⅛ x 98¼
Firebox plates, thickness	⅜ & ½ in.
Firebox, water space	F. 5½, S. & B. 5 in.
Tubes, number and outside diameter	367—2¼ in.
Tubes, length	24 ft.
Heating surface, tubes	5,167 sq. ft.
Heating surface, firebox	212 sq. ft.
Heating surface, total	5,379 sq. ft.
Grate area	75.3 sq. ft.
Smokestack, diameter	20 in.
Smokestack, height above rail	15 ft. 5 11/16 in.
Center of boiler above rail	120 in.
TENDER.	
Tank	Water Bottom
Frame	15 in. Center, 12 in. Side Sills
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	9,000 gals.
Coal capacity	14 tons

EQUALIZATION OF MALLET ARTICULATED LOCOMOTIVES.

BY W. E. JOHNSTON.

It seems to have been the practice in this country in designing Mallet articulated locomotives, to equalize all the driving springs of the front engine together and with the leading truck if one is used. This arrangement gives practically a three-point support to the boiler and prevents local stresses of a diagonal nature on uneven track, or when entering or leaving curves on which the outer rail is elevated. The stability of the locomotive is, however, very materially reduced by this arrangement, possibly to a dangerous extent with certain spring rigging arrangements on the back engine.

Figure 1 shows the situation on an engine of the 2-8-8-2 type equalized according to the usual method and with the back end of both trailer equalizers resting on a single cradle casting in the trailer truck. Considering only the boiler, rear engine frame, high pressure cylinder and such parts as are rigidly attached thereto, ABC is the three point or triangular support and CG the center of gravity. The stability of the locomotive then depends on the distance of the center of gravity from the sides AC and BC of the triangle. The width of the base AB of the triangle depends on the spring arrangement of the rear engine, and is equal to the distance between frames on engines without trailing trucks.

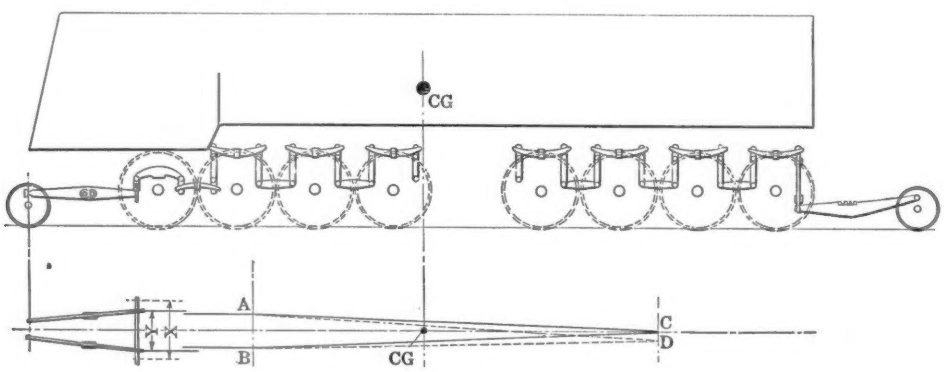


FIG. 1.

On engines with trailing trucks using a transverse equalizer as shown in Figures 1 and 2, the width $AB = \frac{W1}{W2} \times Y$ where Y is the distance between the points at which the trailer equalizers bear on the transverse equalizer, $W1 =$ weight on driving springs of rear engine and $W2 = W1$ plus weight on trailer springs.

This is due to the fact that the transverse equalizer will turn about one of the bearings for the trailer equalizers as a fulcrum if the turning moment due to the difference in weight on opposite sides of the engine resulting from centrifugal force or other causes, exceeds the maximum turning moment which the trailer equalizers can exert in the opposite direction. The total pressure of the two trailer equalizers on the transverse equalizer is obviously equal to the upward pull of the driving spring hangers or $P + P'$, Fig. 2.

This may all be concentrated on one equalizer. $\frac{Y}{2}(P + P')$ then will equal the maximum turning moment the trailer equalizers can exert to prevent rotation of the transverse equalizer, and also the maximum turning moment due to inequalities in weight on opposite sides of the engine.

If the distance between the front end of the trailer equalizers is made equal to the distance between the driving springs with or without a transverse equalizer the turning moment will be $\frac{X}{2}(P + P')$, Figure 2, in which X equals the distance between the frame centers.

The factor $\frac{W1}{W2}$ of the equation $AB = \frac{W1}{W2} \times Y$ applies only to locomotives having the rear end of both trailer equalizers resting on a common support as in the case of trailer trucks in which a single cradle casting acts as a combined truck center pin, swing bolster and equalizer support. With this arrangement, the trailer springs do not assist in righting the engine as the load from the trailer equalizers is carried on the cradle near the center of the engine and the trailer acts as a single point of support. The effect of carrying a portion of the weight of the rear engine on a support at the center of the engine is, obviously, to reduce the resistance to rolling in the same proportion, or about ten per cent. in ordinary 2-8-8-2 designs.

In Figure 1, if $Y = 25\frac{1}{2}''$, AB equals about 23″ and the distance from the center of gravity to the sides AB and BC of the triangle will equal 6½″. This will be the condition on straight track. On curves, however, the center of bearing pressure between the boiler and the front engine is on the center line of the engine frame and on a curve to the right, ABD, shown dotted, would become the triangle of support instead of ABC.

On a 10° curve CD equals about 8″, then the distance from the center of gravity to the side AD will equal about 3¼″, giving an extremely small margin of safety.

The distance between centers of the driving bases of the front and rear engines will not be more than about 25 feet for 0-8-8-0 and 2-8-8-2 types, and the difference between the elevations of the outer rail in this distance will not usually exceed ¼″.

Heavy engines of these types must necessarily have good and substantial track. The necessity for three point support, therefore, seems to be largely imaginary and of much less importance

than the increased stability to be gained by changing the equalization.

Figure 3, herewith, shows a spring rigging arrangement for engines of the 2-8-8-2 type. This gives five points of support for the parts above the springs, but each of these five points of support has from three to five points of support on the rails, so that the effect of low spots in the track at rail joints, at edges of the turntable or other inequalities will be distributed between enough springs so as not to have any injurious effect.

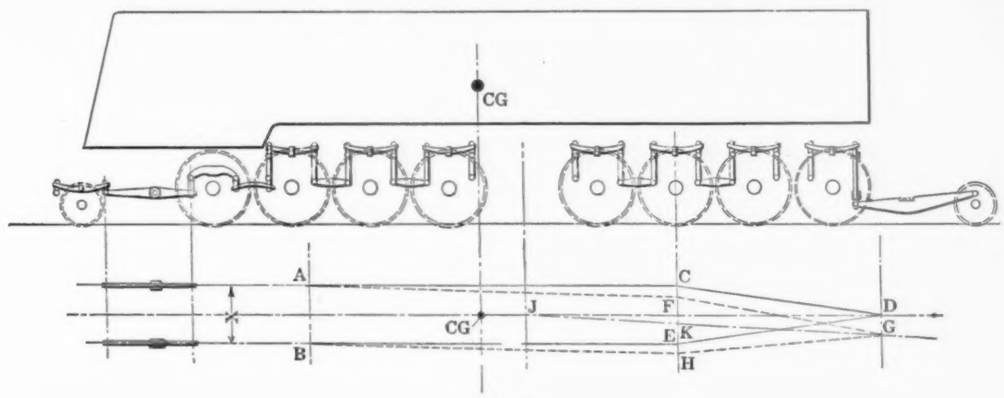


FIG. 3.

In Figure 3 the polygon ACDEB represents the five point support for the parts above the springs. The distance of the center of gravity from the edge of the support would be 21½" on an engine with 43" frame centers standing on straight track. On a 10° curve the distance would be about 18½", and the distances from the center of gravity to the side of the support with the arrangement as shown in Figure 3 are therefore equal to approximately 3 to 5 times the corresponding distances in Figure 1, the increase in ultimate stability being proportional.

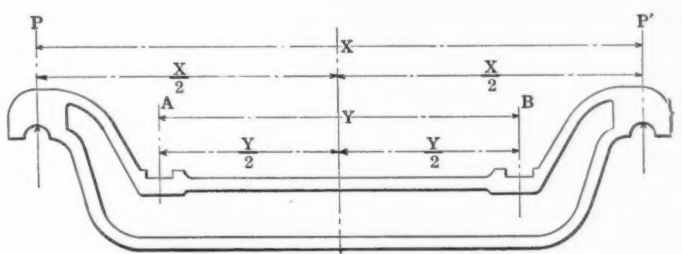


FIG. 2.

The spring rigging arrangement for the front engine shown in Figure 3 is known to be entirely practical and satisfactory, as it is now in use on some engines originally equalized like Figure 1, which gave trouble from the springs of the front engine getting out of their proper positions.

HORSEPOWER REQUIRED FOR MACHINE TOOLS.

The determination of the horsepower required for driving machine tools calls for the exercise of considerable judgment, especially in the case of alternating current motors where a power factor enters into consideration. Exhaustive tests have been made to determine the amount of power required to drive tools, but it is to be regretted that many of these tests are lacking in essential features that would make them valuable. Conclusions drawn from incomplete data are apt to be misleading; as in the case of tests made with motors which are considerably underloaded or overloaded, and where efficiencies are not taken into consideration; or where the material used and duration of test are not stated; or where there has been failure to state whether the test was a practical one or merely a breakdown test. The conclusions drawn from breakdown tests are often deceptive and should not be used for determining power to drive tools; also it does not follow that a tool which stands up longer than another under breakdown conditions, will do the same under practical conditions. The majority of the formulas now in existence for computing horsepower required for tools are generally misleading and useless, and no general formula that would be of practical value has been developed, as the power required varies with the metal worked, the cutting speed and many other conditions.

The construction of the tool is seldom taken into consideration when estimating horsepower, yet some of the worm-driven tools are notoriously inefficient. Other tools are so constructed that the greatest part of the power delivered to the tool is consumed in friction losses and not in useful work; again, the tool may be constructed upon approved lines but may not be stiff enough to stand the strains to which it is subjected, thereby causing considerable loss of power, all of which, as well as the difference in power due simply to the shape of a cutting tool, has been repeatedly proved by tests. In one instance, it required 72 per cent. more power to drive a plain spiral milling cutter than the same cutter nicked.

The advent of the high-speed steel and the high-power tools, together with the increased speed of old tools, makes much of the data bearing on horsepower collected up to a comparatively short time ago, of somewhat doubtful value. From the above, and from the fact that the duty required of a tool in one shop may be more severe than that in another, it will be seen that it cannot be accurately stated that a definite size of motor is required for a given tool. In the majority of cases, however, the horsepower for small tools has been pretty well fixed. With the larger tools the variation in horsepower required is much more pronounced, and at the same time is more important on account of the size of the motors involved. This variation in horsepower is often as much as 4 to 1 and sometimes even 6 to 1.—*Chas. Fair before A. S. M. E. and A. I. E. E.*

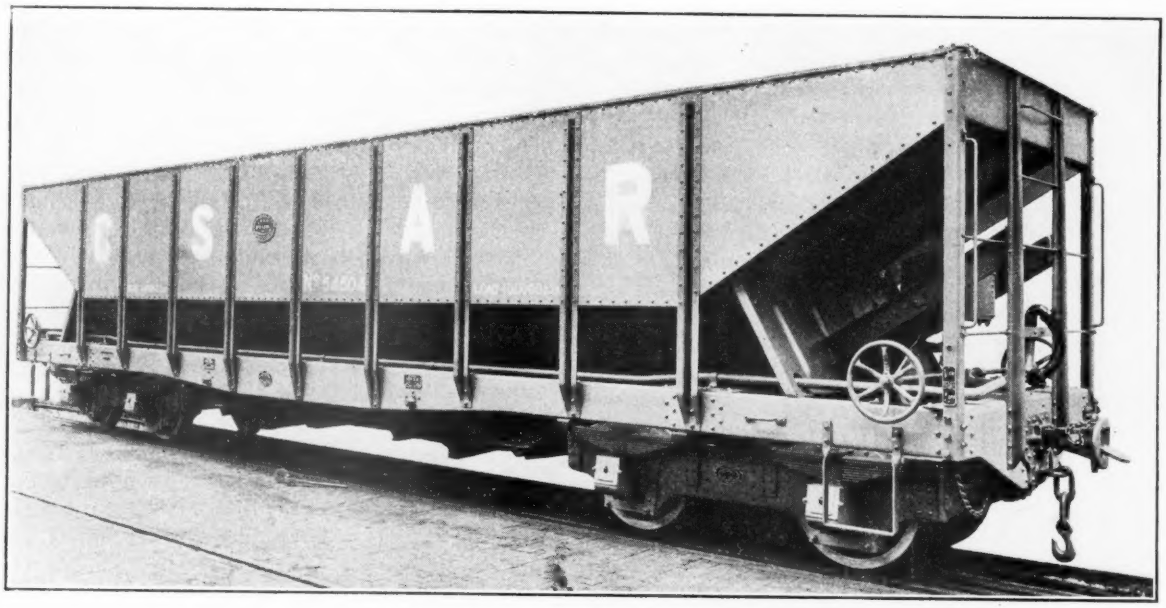
United States Bureau of Mines.—This new bureau was established July 1 with the transfer from the Geological Survey to the bureau of all work relating to mine and fuel investigation and including the fully equipped testing station at Pittsburgh. The publications of the Survey relating to mine and fuel investigations will in the future be distributed by the Bureau of Mines, the last bulletin of the Survey, "The Explosibility of Coal Dust," by G. S. Rice, being issued about August 1. Following this the Bureau of Mines will issue *"Volatile Matter of Coal"*; *"Coal Analysis,"* by N. W. Lord; *"Final Data Regarding Steam Tests,"* by L. P. Breckenridge; *"North Dakota Lignite as a Boiler Fuel,"* *"Producer Gas Tests in 1905-07,"* *"The Coke Industry as Related to the Foundry,"* *"Coal for Eliminating Gas,"* and *"Petroleum as Fuel for Boilers."* The newly created Federal bureau is about to make up a permanent mailing list of those interested in receiving news concerning its work and copies of the bulletins, and all persons who care to have their names on the list are requested to notify the Director of the Bureau of Mines, Washington, D. C.

100,000 LB. NARROW GAUGE HOPPER CAR.

CENTRAL SOUTH AFRICAN RAILWAY.

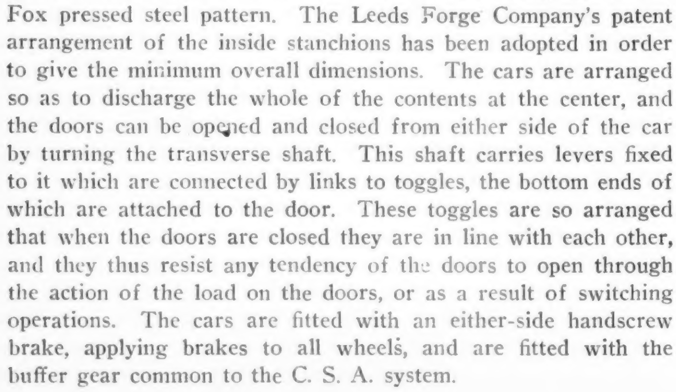
For use in the coal traffic in the Rand district around Johannesburg, the Central South African Railways has purchased five experimental self-discharging hopper cars, designed and built by the Leeds Forge Company, Limited, of Leeds (England). This company has also during recent years built two hundred and fifty 85,000 lb. capacity all-steel hopper cars for this road. The Central South African Railway is 3 ft. 6 in. gauge and these cars are said to be the largest freight rolling stock which has yet been constructed for any narrow gauge railway system.

From the illustration, it will be seen that the body of the car, which is constructed throughout of steel, is carried on Fox's



100,000 LB. STEEL HOPPER CAR FOR 3 FT. 6 IN. GAUGE RAILROAD.

patent pressed steel underframe, the latter being carried at either end on the spherical centers of two four-wheel trucks, also of the Fox pressed steel pattern. The Leeds Forge Company's patent arrangement of the inside stanchions has been adopted in order to give the minimum overall dimensions. The cars are arranged so as to discharge the whole of the contents at the center, and the doors can be opened and closed from either side of the car by turning the transverse shaft. This shaft carries levers fixed to it which are connected by links to toggles, the bottom ends of which are attached to the door. These toggles are so arranged that when the doors are closed they are in line with each other, and they thus resist any tendency of the doors to open through the action of the load on the doors, or as a result of switching operations. The cars are fitted with an either-side handscrew brake, applying brakes to all wheels, and are fitted with the buffer gear common to the C. S. A. system.



DETAIL OF DOOR OPERATING MECHANISM.

The following are some of the leading dimensions:

Length over buffers	42 ft. 9 in.
Length inside	40 ft.
Width over all	8 ft. 4 in.
Width over headstocks	8 ft. 2¾ in.
Width inside	8 ft. 2 in.
Total height	10 ft.
Wheels, diameter	2 ft. 10 in.
Truck wheelbase	5 ft. 6 in.
Centers of trucks	28 ft. 6 in.
Buffer height (unloaded)	2 ft. 11 in.
Centers of journals	5 ft. 6 in.
Net capacity	1,700 cu. ft.
Load	100,000 lbs.
Weight	40,880 lbs.

STATISTICS OF RAILROADS.

The preliminary abstract of the report of the Interstate Commerce Commission on the statistics of railways in the United States for the year ending June 30, 1909, contains the following information: On June 30, 1909, there was a total single track mileage of 236,868.53, an increase of over 3,000 miles from the previous year. The number of railways included in the report is 2,196. There were 57,212 locomotives in service at that date, an increase of 479 over the previous year. Of these 13,317 are passenger, 33,935 freight, 8,837 switching, the remainder being unclassified. The total number of cars of all classes are 2,218,280, or about 13,000 less than the previous year. The average number of locomotives per thousand miles of line was 243, and of cars 9,423. The total number of employees on steam roads was 1,502,823, an average of 638 per 100 miles of line. This does not include the employees on switching and terminal companies, which are not considered in any of the summaries. The total capitalization at par value was $17,487,868,935, representing a capitalization of $59,259 per mile of line. During the year there were 253 passengers killed and 10,311 injured. Of these, however, but 86 passengers were killed and 4,805 injured because of collisions or derailments. The total number of persons other than employees or passengers killed was 5,859, injured 10,309.

NEW CHICAGO AND NORTHWESTERN TERMINAL.—The new Chicago terminal of the Chicago & Northwestern Railroad has progressed far enough to give an idea of the remarkably attractive and imposing appearance which the finished structure will present. The station building and train shed occupy an area of 320 by 1,290 ft., all buildings covering 20 acres of ground. The tracks in the train shed have a capacity of 200 cars. The total daily capacity of the whole station will be 250,000 passengers which can be handled without any confusion or crowding. The building contains all possible facilities and conveniences for travelers.

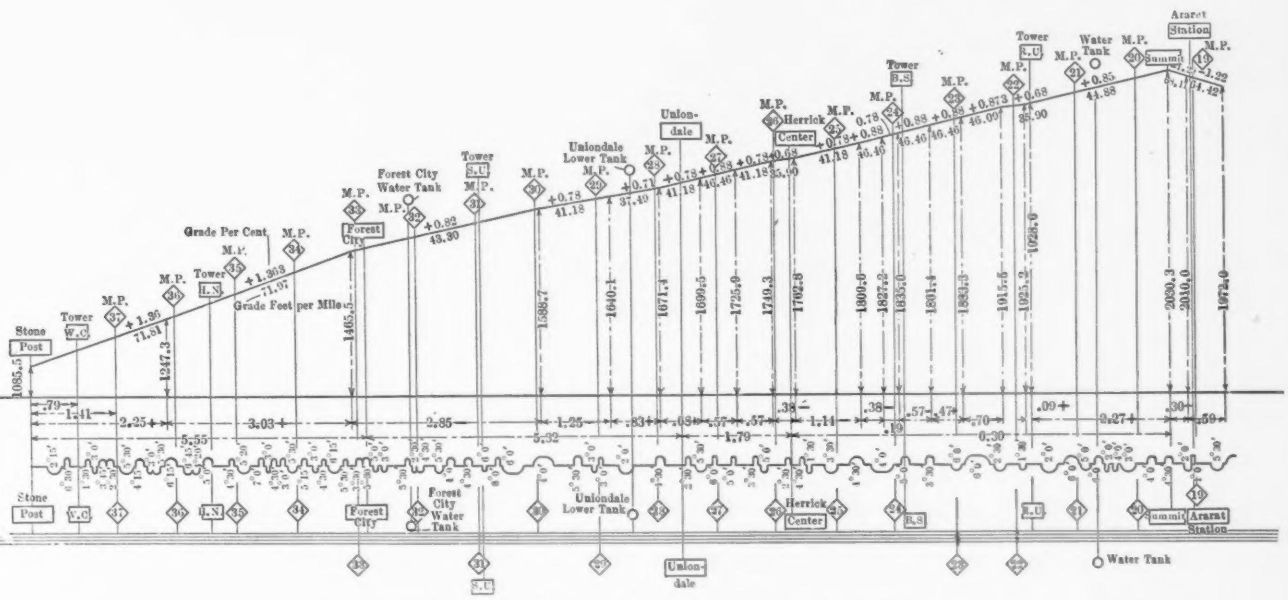
OPERATION OF MALLET COMPOUNDS IN PUSHER SERVICE

DELAWARE & HUDSON CO.

On page 207 of the June issue of this journal appeared an illustrated description of some very powerful Mallet locomotives of the 0-8-8-0 type, six of which had been delivered to the Delaware and Hudson Co. by the American Locomotive Company. These locomotives were designed to take the place of two very large pusher engines which it had been necessary to use on the grade out of Carbondale, Pa.

After they had been in service for a short time, some comparative test runs were made to determine the exact cost of operating on this grade under the two methods. Four runs were made with the same two pushers of the class E-5 type,* then four runs with one of the Mallets, followed by four more with another Mallet. The tonnage of all trains was practically the same. Observations were taken and determinations made of the number of cars handled by the pusher alone, the steam pressure, coal burned, draft, water consumption, etc. These are given in the table below.

It will be seen from the results that one Mallet performed almost exactly the same work as two of the E-5 engines with a saving of about 44 per cent. in coal and 27 per cent. in water. Since the coal used on the Mallets was not as expensive a grade the results are all the more striking.



PROFILE OF LINE FROM W. C. TOWER TO SUMMIT—D. & H. CO.

Some of the general dimensions, weights, etc., of the two classes are given below:

Class	E 5	H
Type	2-8-0	0-8-8-0
Weight, total, lbs.	246,500	445,000
Weight, drivers, lbs.	217,500	445,000
Tractive effort, lbs.	49,690	105,000
Diameter drivers, in.	57	51
Steam pressure, lbs.	210	220
Cylinders, diameter, in.	23	26 & 41
Cylinders, stroke, in.	30	28
Boiler, diameter, in.	83¾	90
Tubes, number and size	493—2	446—2¼
Tubes, length	14 ft. 6 in.	24 ft.
Grate area, sq. ft.	99.85	99.85
Heating surface, total, sq. ft.	4,045.5	6,629

The average results of four runs with two class E-5 and eight runs with the Mallets (four with each) are as follows:

No. of locomotives	2	1
Class	E 5	H
Type	2-8-0	0-8-8-0
Cars in train	44.8	45
Handled by pusher	30.3	30.1
Actual tonnage of train	2,279.3	2,276.6
Tonnage moved by pusher	1,504	1,490.8
Percentage moved by pusher	65.99	65.48
Running time—W. C. Tower to Forest City	38 min.	45.5 min.
" " Forest City to Uniondale	18.8 min.	21.8 min.
" " Uniondale to Summit	46 min.	43.1 min.
" " W. C. Tower to Summit	1 hr. 42.8 min.	1 hr. 50 min.
Miles per hour—W. C. Tower to Forest City	7.52	6.28
" " " Forest City to Uniondale	14.20	12.25
" " " Uniondale to Summit	11.69	12.47
" " " W. C. Tower to Summit	10.61	9.88
Average steam pressure—		
W. C. Tower to Forest City	200.	203
Forest City to Uniondale	191.5	199
Uniondale to Summit	198.5	199
W. C. Tower to Summit	196.5	200
Pounds of coal burned—		
W. C. Tower to Forest City	6,281	3,784
Forest City to Uniondale	4,540	2,572
Uniondale to Summit	8,253	4,273
W. C. Tower to Summit	19,074	10,629
Kind of coal*	———	———
Pounds of coal per hr. per sq, ft. grate area	55.8	57.9
Draft, inches water—Front of diaphragm	———	6.21
" " " Back of diaphragm	———	4.31
" " " Firebox	———	2.30
" " " Ash pan	———	.29
Gallons water used—W. C. Tower to Forest City	4,334	3,233
" " " Forest City to Uniondale	2,814	2,056
" " " Uniondale to Summit	5,496	3,916
" " " W. C. Tower to Summit	12,644	9,205
Coal burned per 1,000 ton miles	.349	.196
Cost per 1,000 ton miles	.768	.431

* E 5 pushers used a mixture of pea 50 per cent., buckwheat 40 per cent., soft 10 per cent. The Mallets used a mixture of pea and soft which averaged, pea 48.75 per cent., soft 51.25 per cent.

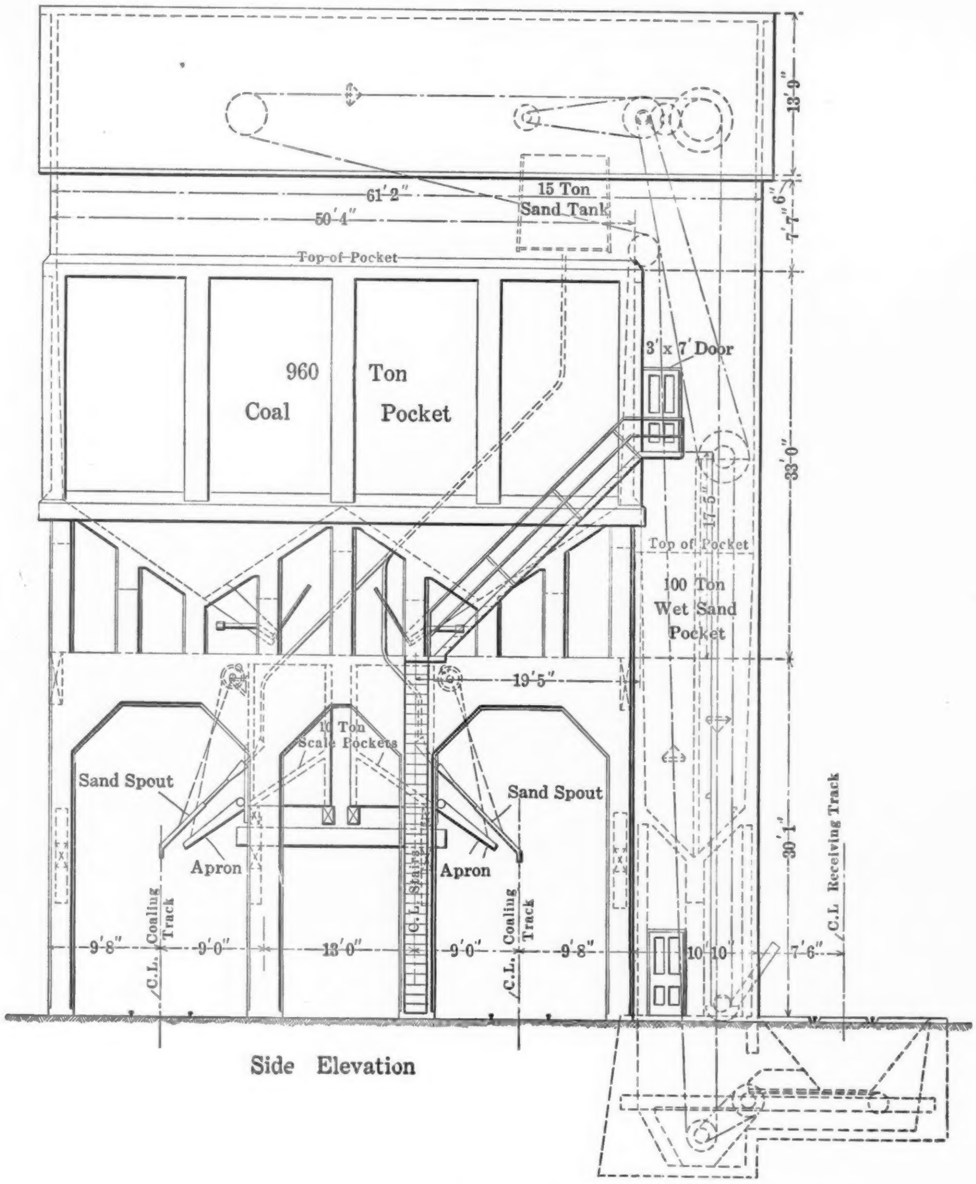
* See AMERICAN ENGINEER, January, 1907, page 22.

Growth of Pension Systems.—With the beginning of the year, 165,000 railroad employees have been added to the 500,000 in this country to whom pension plans already apply. This large increase is due to the action of the New York Central and Rock Island lines, which have announced the installation of pension departments. The latest government report on the number of railroad employees puts the total for the country at 1,672,074. Of these approximately 665,000, or about 40 per cent., serve the roads which have pension systems. Companies that now bestow pensions on employees are the New York Central, the Rock Island, the Pennsylvania, the Buffalo, Rochester and Pittsburgh, the Chicago and Northwestern, the Illinois Central, the Santa Fe, the Union Pacific, the Southern Pacific and its affiliated lines, the Lackawanna, the Baltimore and Ohio, the Atlantic Coast Line, the Reading, and Jersey Central.

REINFORCED CONCRETE COALING STATION

SOUTHERN RAILWAY.

Following out the recent engineering practice of utilizing reinforced concrete in large structures, there are at the present time a number of coaling stations in service in different parts of the country constructed in this manner. The service obtained from all of these has been very satisfactory and seems to indicate that this form of construction is particularly well adapted to structures of this kind located at railroad termi-bodies the feature of weighing the coal before it is delivered to the locomotive, which has lately come into extensive use on the Santa Fe lines.* Coal is delivered to the locomotives on two tracks, each of which is served by two 10 ton weighing hoppers supported on Fairbanks platform scales, as shown. In this particular station the entire pockets, as well as the scale beams, are built of reinforced concrete.



ELEVATION OF REINFORCED CONCRETE COALING STATION—SOUTHERN RAILWAY.

nals where they are almost continuously exposed to the smoke and gases so destructive to steel.

It is easy to see that the depreciation on the structure itself where concrete is used is very small and in most cases can be neglected, resulting in no expense whatever for maintenance, while with wood or steel construction or a combination of the two, the maintenance charge is large, as is also the depreciation.

An example of this type of coaling station, located at Asheville, N. C., is shown in the illustrations. A structure of this kind not only presents a very pleasing appearance, but it has the additional advantage of being fireproof, a very important consideration for buildings at railroad terminals.

This station was erected for the Southern Railway Co. and is of the mechanical type with 1,000 tons capacity. It also em-

The foundation for the structure consists of solid concrete piers extending 13 ft. below the top of the rail of the coaling track and resting on wood piling driven to solid rock. Reinforced concrete is used throughout the remainder of the structure in every possible place. The main coal storage pocket without the scale pockets has a capacity of 960 net tons, and the four scale pockets have a capacity of 10 tons each.

Coal is delivered from the main overhead pocket to the scale pockets by gravity, the flow being controlled by under cut gates in the hoppered floor of the former. The scale pockets are provided with drop gates and steel aprons for delivering the fuel to the two tracks running underneath the building.

There is an overhead wet sand storage pocket in the same

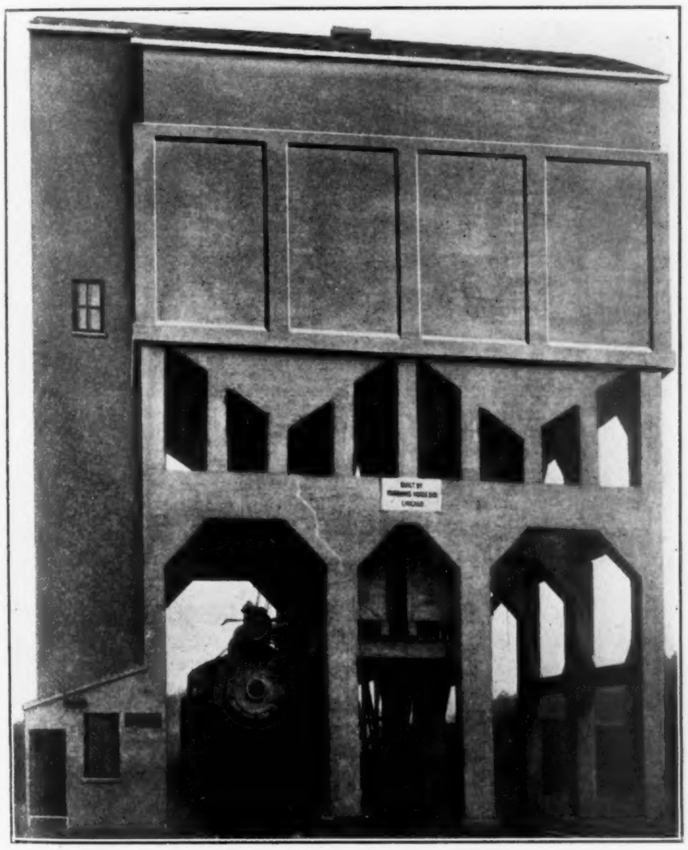
* See AMERICAN ENGINEER, May, 1910, p. 161.

structure with a capacity of 100 net tons. In connection with this the compressor room, sand drying room, elevator housing, machinery supports and roof are constructed of reinforced concrete.

The concrete for the main structure above the foundation consists of one part Portland cement, two parts granite screenings, and four parts of broken stone; while that used in the foundation consists of one part cement, three parts sand, and five parts broken stone. The reinforcing throughout consists of Johnson's corrugated steel bars.

COAL HANDLING MACHINERY.

Coal is delivered to a 15 by 20 ft. receiving hopper located underneath the receiving track and is carried to the elevator by an automatic loader, which insures the proper amount of coal being delivered to each bucket of the elevator, The elevator and conveyor, which carries it up and distributes it to the overhead pocket, consists of "V" shaped buckets mounted on a steel roller chain and has a capacity of 100 net tons per hour. The power for driving the elevator is supplied by a 30 h. p. alternating current



A SOLID CONCRETE COALING STATION.

motor located above the main pocket and connected to the driving shaft by a leather belt.

SAND HANDLING MACHINERY.

Wet sand is shoveled into a small receiving hopper located on the outside wall on a level with the top of an ordinary gondola car, and then elevated to the wet sand storage pocket by a centrifugal discharge elevator, consisting of a rubber belt with small malleable iron buckets. The capacity of the elevator is 10 tons per hour.

The sand drying room is directly under the wet sand pocket, so that the sand is delivered by gravity to a steam dryer in the drying room. After being dried and screened, it is delivered to a sand drum, also located in the same room, from which it is finally elevated through a four inch pipe to the overhead dry sand storage bin by means of compressed air.

A small compressor connected by a belt to a 5 h. p. motor, both of which are located in a separate house on the ground level, supplies the compressed air for this elevating scheme. The dry sand bin is equipped with two sets of outlet fixtures and spouts so that locomotives on either of the coaling tracks may be supplied.

The entire coaling station, including foundations and equipment, was designed and erected by Fairbanks, Morse & Co., all the machinery and appliances being products of their factory. The station has been in successful operation since January, 1907.

WHY MANUFACTURERS DISLIKE COLLEGE GRADUATES.*

The central idea that the boy gets at college is training, training of the mind, storing the mind full of things. Now I say, without the slightest hesitation, that for success in life, intellectual training comes second or third. Without the slightest question, character comes first; good sense, second, and intellectual training third. The entire emphasis of the college life is on intellectual training. As long as the man commits no offense which sends him to jail, it is very little of the business of the management of those universities what those boys do.

What is the remedy for these faults? I do not believe there is any panacea for all faults, but I do believe that there is a great palliative possible. I believe that every young student in our colleges, from the student who intends to be a minister, on the one hand, to the mechanical engineer, on the other hand, should leave college at the end of the freshman year and spend at least one year in actual hard work in a shop of some kind. I say shop, because he will be certain to be under careful and constant supervision when working in a shop as a workman, alongside workmen.

I would not send them there with the idea of getting intellectual training. If they do, it is a mere incident. I would send them there mainly for the purpose of giving them a real look at life's work and give it to them early enough so as to affect the last three or four years of their college life. When they start work in a shop, under good rigid discipline, they then begin to get the character training, which is almost entirely lacking at college. They then begin to learn the great lesson of life, that almost nine-tenths of the work that every man has to do is monotonous, tiresome and uninteresting. Then they start to develop the character which enables them to do unpleasant, disagreeable things. This is the greatest training, to my mind, which they get in the shop. They learn that life is made up mainly of serving other people, not that the world is there to teach them something new. I think that almost invariably they start into the shop with the common idea, "Now I am here to learn something, to get something in this shop that is going to be a fine engineering education for me." They fail at once, for there is no great intellectual training in the shop. Many of them cannot stand the monotony and fail to get the real character training that comes from that work.

* Extract from the discussion of Frederick W. Taylor before the Society for the Promotion of Industrial Education.

LOCOMOTIVE TESTING PLANT, UNIVERSITY OF ILLINOIS.—Upon the recommendation of Robert Quayle, Superintendent of Motive Power and Machinery, the locomotive testing plant of the Chicago & North-Western Ry. has been presented to the University of Illinois. It is understood that the plant will be held by the university pending the construction of its proposed transportation laboratory. The testing plant was designed under the general direction of Mr. Quayle, aided by E. M. Herr. The drawings were developed under the immediate direction of E. B. Thompson, now Supt. M. P. and M. of the C., St. P., M. & O., but who at that time was chief draftsman for the C. & N. W. The proceedings of the Master Car Builders' Association will show that this plant was an important factor in the development of several committee reports dealing with the design of exhaust pipes, steam passages, draft pipes and stacks. It is announced by Dean Goss, of the College of Engineering, that the plant at the university will constitute a portion of the equipment of the School of Railway Engineering and Administration, and that when installed it will be operated under the immediate direction of Professor Edward C. Schmidt.

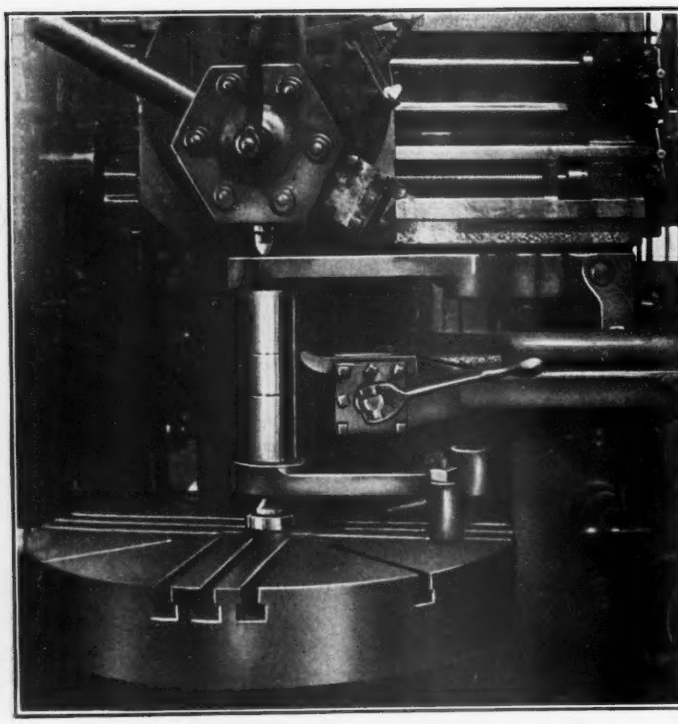
MACHINING A LOCOMOTIVE ROCKER SHAFT

CHAS. D. CHANDLER.

The accompanying illustrations are taken from a modern and recently equipped Western railroad shop in which the variety and adaptability of the machine tools are considered quite complete for any and all lines of work relative to the repair and maintenance of the class and style of power in use.

There are in service on this railroad a number of Walschaert valve gear engines using rocker shafts with arms extending in the same direction and also with inward projecting bosses and fork ends. In the natural course of service and wear it was found necessary to "true up" the shaft bearings, for which operation it was discovered that no engine lathe in the shop had the proper swing and a sufficiently narrow tool rest and cross-slide to permit of any travel of the carriage between the revolving arms. The marked success with which this was eventually accomplished is well shown by the pictures of the different styles of shafts mounted on centers and being machined in a vertical turret lathe. The merits of the lathe feature of this arrangement are quite decidedly evident in this case by using one of the turret face holes for a center virtually conforming to the ordinary engine lathe tail stock, the other center being in the table or face plate which corresponds to the head-stock to which are also secured the bolts for driving the shaft around.

If the reader will now turn the bottom of the picture to the left hand, the similarity to all lathe conditions will be quite apparent. With the shaft accurately and securely centered, the narrow side head is then most advantageously brought into use, with relatively the same effect as that of the ordinary lathe carriage and tool post. The shaft is relieved undersize just in the center, thus leaving a bearing portion about 4 or 5 inches long

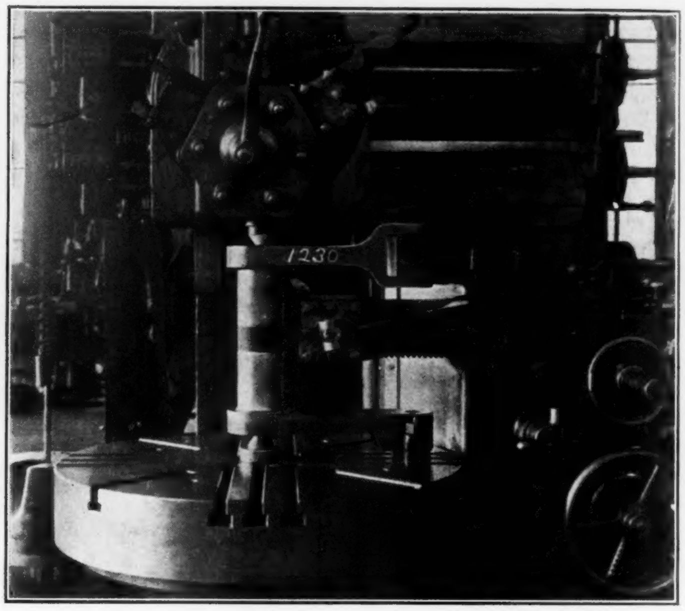


MACHINING ROCKER ARM ON BULLARD VERTICAL TURRET LATHE.

to be trued up, which can be turned full length with one tool setting by using the narrow side head.

The boxlike section and liberal bearings of the side head make this a very rigid operation, favorable also to which are the short heavy centers just permitting the arms to pass under the crossrail.

While the above is submitted as somewhat of a novelty, it strongly emphasizes the increasing utility of the modern tool



ANY TYPE OF ROCKER CAN BE MACHINED WITH EQUAL FACILITY.

and its possibilities when local conditions are given a little study and careful attention. The machine on which the above was accomplished is a 36-inch vertical turret lathe built by The Bullard Machine Tool Co.

RECORD FOR REPAIRING LOCOMOTIVES.

The Sayre shops of the Lehigh Valley Railroad are said to have established a new record for repairing locomotives. This record covers a period of seven months from September 30, 1909, to May 1, 1910, during which time one repaired locomotive was turned out every 3½ working hours. The force of employees at this shop includes 1,000 men in the locomotive department, 450 in the freight car department, and 150 on passenger cars. The work done in the locomotive department during the period mentioned is given in the following table:

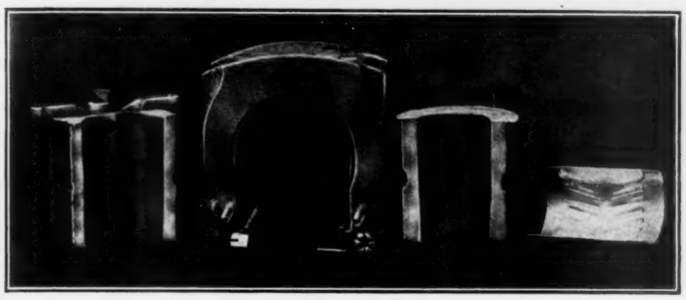
Month.	Rebuilt.	New Fireboxes.	Back Flue-Sheet.	Engines, Total.	Hours Worked.	Hrs. Worked Per Engine Repaired.
Oct., 1909....	..	5	6	50	168	3.4
Nov., "	1	4	5	47	152	3.2
Dec., "	1	4	5	52	184	3.5
Jan., 1910....	1	6	5	53	168	3.2
Feb., "	1	3	6	41	153	3.7
Mar., "	1	4	8	47	198	4.2
Apr., "	2	6	11	61	212	3.3
Total	7	52	46	351	1,235	3.5

Power Consumed by Machine Tools.—A graphic recording wattmeter in circuit with the motor on a tool not only tells the actual power consumed by the machine, but also shows whether the tool is operating at its maximum rate, by registering the time of unproductive cycles or the length of time the tool is idle; and by analysis, the cause of the lost time may be discovered and result in a change of conditions with a corresponding increase in production. Poor lineshaft alignments have been detected by watching the integrating wattmeter. Many shops are paying dearly for lack of attention to alignment of shafts, etc.—*Chas. Fair before A. S. M. E. and A. I. E. E.*

DRIVING BOX WITH REMOVABLE BRASS.

A design of driving box with removable brass and arranged for carrying a large amount of grease in a cavity above and around the brass, has been in use on the Wabash Railroad for over a year, giving results that are in every way satisfactory. It was designed and has been patented by L. K. Smith, assistant master mechanic at Moberly, Mo.

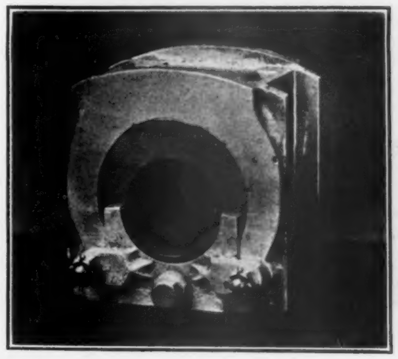
The removable brass has a flange on the inside which sets in a recess in the box and is slightly tapered toward the outside on the lower faces. It is held in place by the heavy cellar which



DRIVING BOX WITH REMOVABLE BRASS DISMANTLED.

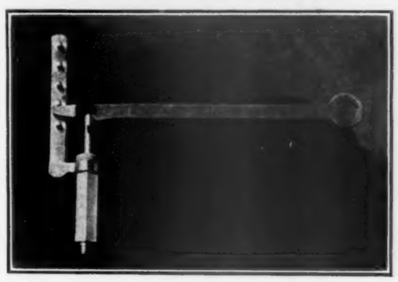
is dovetailed into the box at the bottom and bears against the tapered face of the brass at the top. This cellar is drawn up and held in place by two studs on the inside of the box. The lugs on the cellar and arrangement of the studs are clearly shown in the illustration. When the cellar is drawn into place the brass is securely held and has a bearing on the box on all its upper surface except where the latter is cored out for the grease cavity. There are no studs or other fastening for securing the brass in place and it is easily possible for one man to remove and replace a brass under a locomotive in one hour.

An original scheme is employed for a lubrication reservoir of



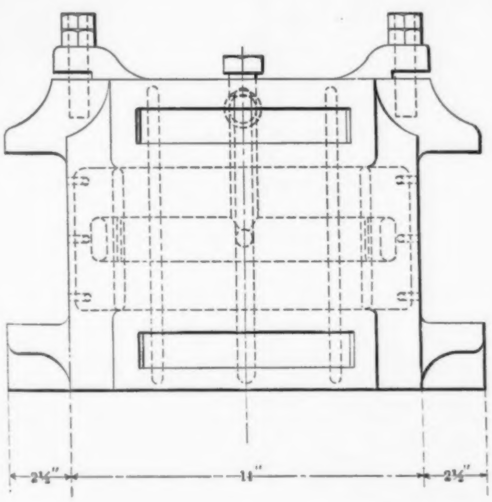
DRIVING BOX WITH REMOVABLE BRASS ASSEMBLED.

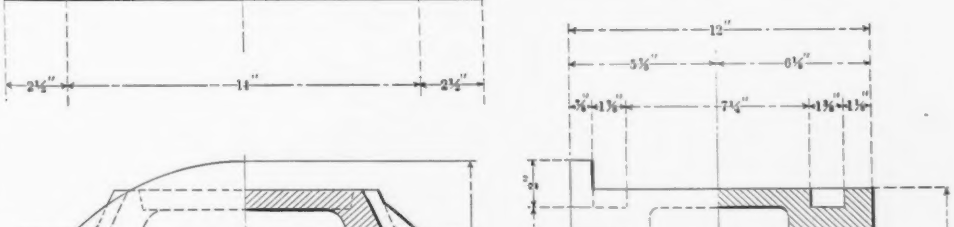
capacity sufficient to last from one shoping to the next under ordinary circumstances. This consists mainly of a large cavity in the box above and around the brass which is filled with grease as will be explained later. The brass is provided with grooves in the usual manner and openings from each communicate with the reservoir. Under the journal there is a corrugated steel sheet held up against the axle by two small coiled springs seated in the cellar. This plate stands away from the journal at the center and has a fit only at the ends. It catches the lubricant brought down by the journal and is soon filled with grease. Any overflow is automatically returned to the reservoir through passages provided for that purpose.



PUMP FOR FILLING RESERVOIR WITH GREASE.

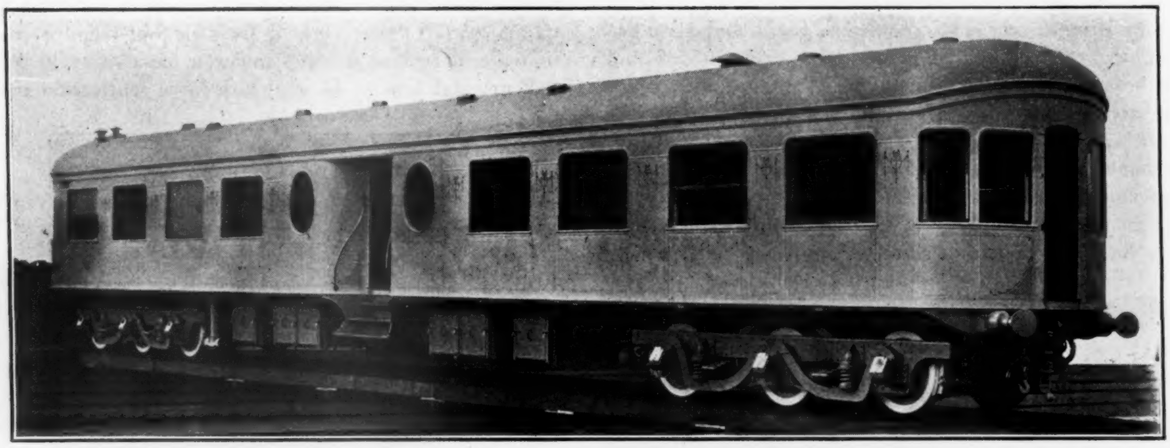
The packing of driving box with grease is a very simple matter. Either of the plugs, one under the cellar and one on the side of the cellar, is removed and the device, especially designed for packing the box, is applied, the operator filling the pump with grease cartridges 1 inch in diameter and about 4 inches long, each cartridge weighing 2 ounces. This is forced into the box until the cavities are filled. The grease, after entering the cellar, is forced up through the cavities in the cellar and brass, to the main reservoir. The grease is fed to the journal automatically by expansion, when the engine is in motion.

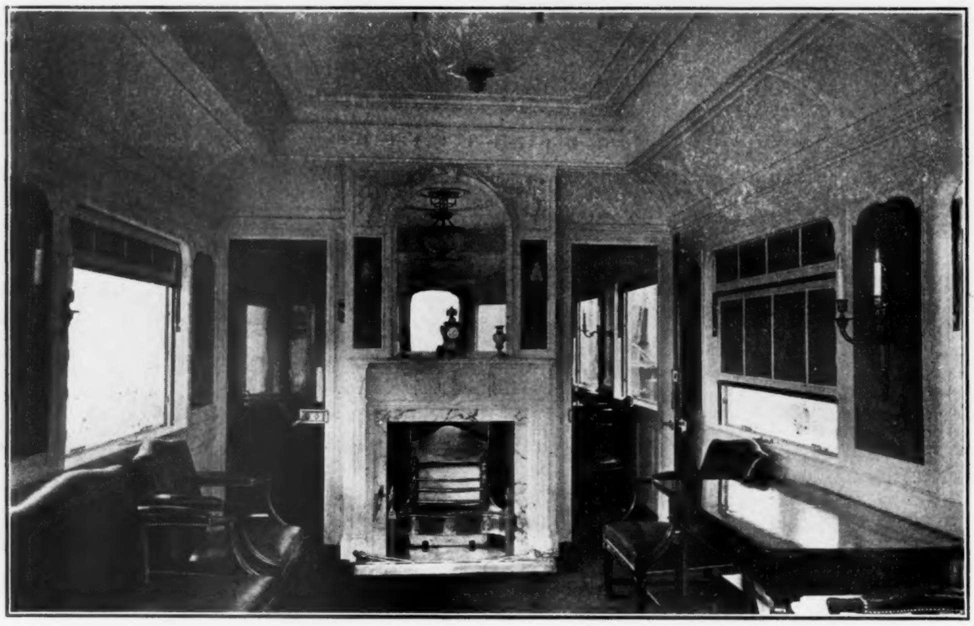


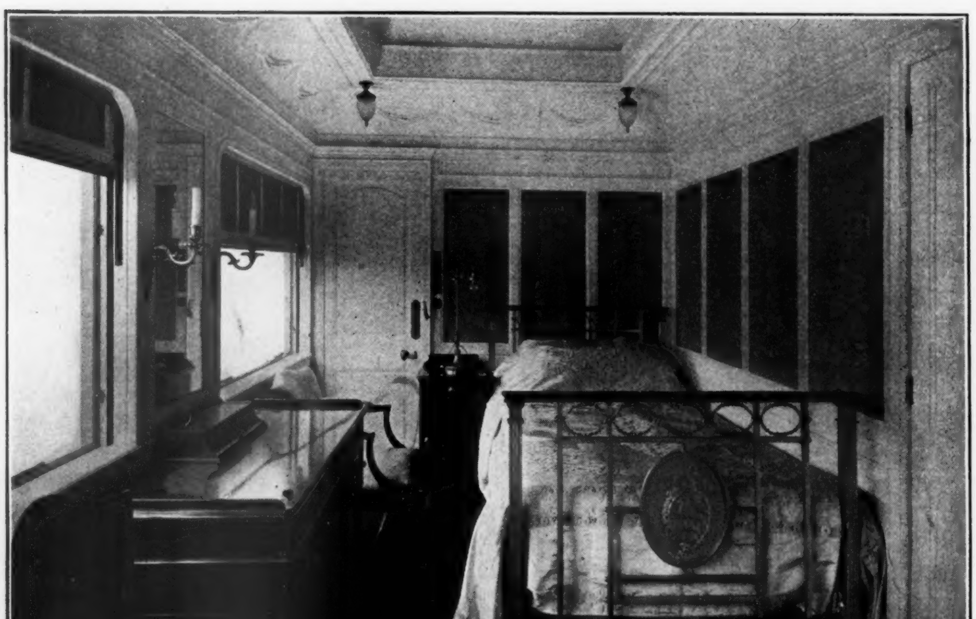


DETAILS OF DRIVING BOX WITH REMOVABLE BRASS.

It is reported that the Santa Fe intends to convert all passenger locomotives running between Kansas City, Mo., and Newton, Kan., to oil burners.







EXTERIOR AND INTERIOR VIEWS OF A PRIVATE CAR BUILT FOR THE PRESIDENT OF THE ARGENTINE REPUBLIC.

PRIVATE CAR FOR SOUTH AMERICA.

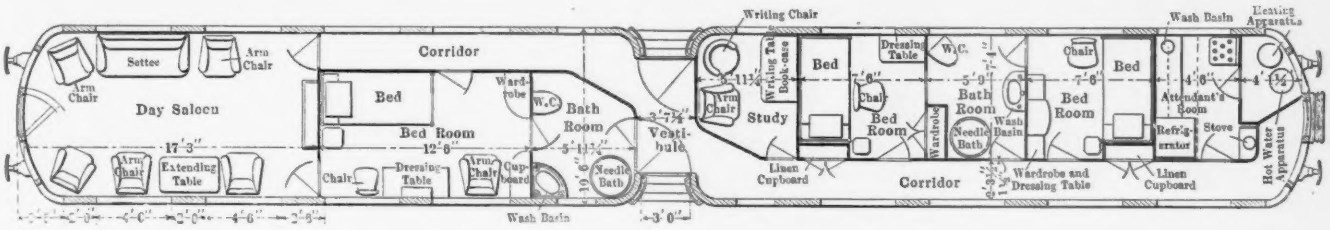
An unusually luxurious private car has recently been delivered to the President of the Argentine Republic by the Metropolitan Amalgamated Railway Carriage and Wagon Co., of Birmingham, England. This car will be exhibited at the Buenos Ayres centennial exposition.

In several particulars novelties of design have been incorporated in this structure that improve its general appearance and also increase the available space. This is particularly noticeable in the case of the entrances, which are in the center, the doors being set back about 18 in. from the outside faces of the car, the sides of the body being curved in to meet them, while the roof is taken straight through and forms a canopy over the steps. Another attractive feature is the rounding of the ends and the location of the windows on the corners, permitting an exceptionally broad view from the observation room.

Since the car does not include dining facilities an opportunity has been given to provide unusual space for sleeping rooms and bathrooms. The floor plan shows the general arrangement clearly and well illustrates the exceptional facilities afforded. This is particularly noticeable in the president's bedroom, which measures 7 ft. 3 in. by 12 ft. 6 in. and is adjoined by a 6 by 7 ft. bathroom. The car measures 76 ft. 6 in. over end sills and has a width of 10 ft. 6 in. It is carried on two 6-wheel steel trucks, special care being given to the easy riding qualities.

It is really to the interior and exterior finish that special attention is drawn, and in these particulars it excels anything that has ever been on exhibition. Beginning with the observation room, which is finished in hand carved mahogany, painted white and paneled with green silk and includes a fireplace with a marble hearth and fittings, the same elegance is carried throughout the whole car. In this section the furniture is of the best Spanish mahogany upholstered in dark green leather and the floor is covered with thick green pile carpet. One of the illustrations shows part of the interior of this room and in another is shown the president's bedroom and bathroom. In all of these the artistic electric light fixtures and the particularly pleasing arrangement of the ceilings are evident. In the bedroom the panels and carpet are of a deep blue. In the bathroom the walls and doors are paneled up to the window sills in marble and the fixtures are nickel throughout. The remainder of the car is finished in a similar manner, the study being finished in red.

On the exterior, the car is sheathed with steel and painted an ivory white, decorated in blue and gold. The window frames are of brass, which is polished and the underframes and trucks are painted in a light gray. The car carries two axle generators, large water tanks, etc.



PLAN OF CAR SHOWING ARRANGEMENT OF QUARTERS.

PRESIDENT'S BATHROOM IN PRIVATE CAR.

LOCOMOTIVE CRANE IN STOREHOUSE YARD.

A most useful piece of machinery is a locomotive crane, which can be used for many purposes.

First, in unloading piling and lumber from open cars. I find it costs $6 per car to handle by hand where cars must be moved by hand back and forth to properly assort them on ways of their respective lengths. This same work can be done with a crane for $1.40 per car, or a saving of $4.60.

Car and engine bolsters cost to handle by hand $5 per carload of seventy-five; these can be handled by locomotive crane for 75 cents, or a saving of $4.25.

One hundred 4¼ x 8 axles—by hand $5.50, by crane $1.50, saving of $4. Mounted wheels to axles—by hand 75 cents per car, by crane 17 cents, saving 58 cents. These are only a few instances for which the crane can be used, but it is not necessary for me to enumerate further.

I also find in handling scrap that the cost by hand for an average of 100 cars is $7 per car; with the crane it is $2.83, or a difference of $4.37 in favor of the latter.

The same saving can be accomplished in loading piling and heavy lumber.—*J. F. Slaughter at the Storekeepers' Convention.*

RAPID CONCRETE WORK.—Working on the concrete foundations of the new locomotive shop of the Boston & Maine Railroad at Sommerville, Mass., the Aberthaw Construction Co. installed about 2,000 yards of concrete at a total cost of $1.36 per cu. yd. This low cost on a job of this size was possible because of the erection of a complete construction plant for the work, although it was in operation only about five weeks.

COALING WITH LOCOMOTIVE CRANES

In 1905 the Grand Rapids & Indiana Ry. started the use of locomotive cranes for handling fuel at some of its coaling stations. The experience since that time has been entirely satisfactory and such as to indicate this to be the most efficient system for stations handling from 300 to 400 tons a day.

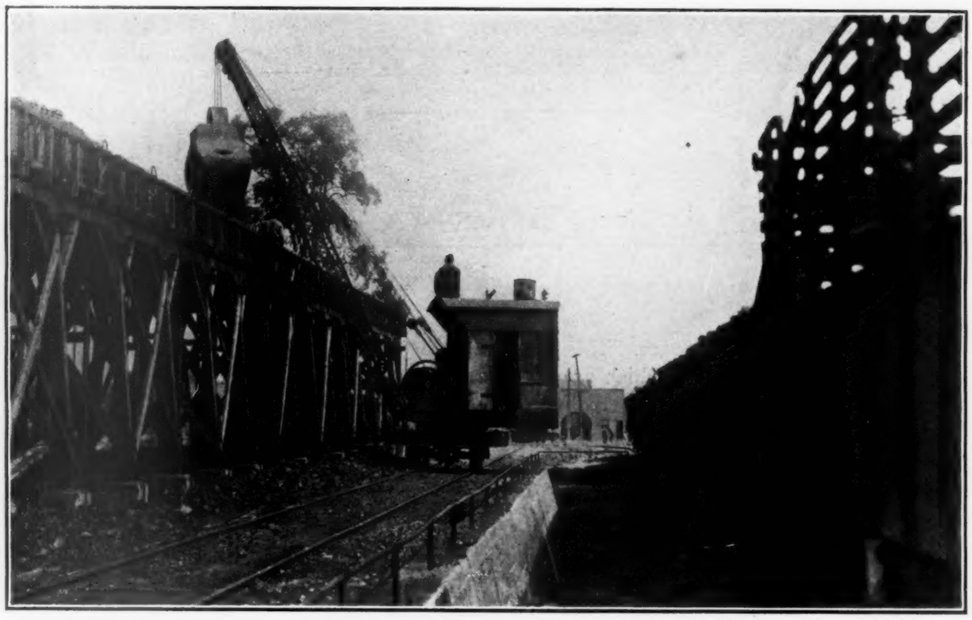
A 600-ton pit is provided at these stations into which the coal from hopper cars is emptied. Other types of cars are emptied by the bucket direct. From either these cars or the storage pit, the fuel is transferred by the crane to either the tender or to a series of elevated 5-ton hoppers seen on the left in one of the illustrations. From these hoppers locomotives can be coaled at any time without delay or at times when the crane is engaged in handling cinders.

This arrangement eliminates many of the objections mentioned in the discussion of locomotive cranes for this service in the series of articles on Locomotive Terminals which appeared in the January, February and March issues of this journal. These briefly were: Use of cars for storage, damage to car equipment and delay to locomotives in taking coal. In this case, there is no damage possible to the hopper cars which of course form a large proportion of the supply, and no serious delay to any cars unless an unusual number of closed bottom cars arrive at one time.

Two men form the entire force at these stations, one is the crane operator and the other a helper whose duties consist largely of shoveling coal from ends and corners of cars, keeping the grounds clean, etc.

At one station a contract is made with the operator to handle all coal from cars or pit to locomotive tender for 3½ cents a ton. At the Grand Rapids station during the month of March, 1910, there were 6,506 tons of coal handled at an average cost, including repairs and supplies, of 4.8 cents per ton on the tender. The repairs and supplies amounted to but .8 cents per ton.

Brownhoist 10-ton cranes are used at these stations, being equipped with 54 cu. ft. two rope, grab buckets. These cranes are arranged for very high speed in operation and are especially suited for this work. They have 35 ft. booms and a radius of from 15 to 35 ft. One of the illustrations shows the bucket at close range. This type of bucket has been found to be particularly adapted for cleaning cars and can be hung either lengthwise or crosswise of the boom as desired by the operator.



LOCOMOTIVE CRANE FILLING ELEVATED COAL HOPPERS.

TYPE OF GRAB BUCKET USED ON LOCOMOTIVE CRANE.

HOT-WIRE SYSTEM FOR TUNGSTEN LAMPS

An ingenious scheme to overcome the brittleness of the tungsten lamp filament when not burning was devised by E. M. Fitz, Electrical Eng'r. of the Pennsylvania Lines West of Pittsburgh, in which he arranges to have a small current passing through the lamp when extinguished, which has been used by his road with great success. On cars using 63 volts (32 cells) the two end cells of the battery, giving 4 volts, are connected to the lamps when extinguished, which keeps the filaments at a faint dull red and makes them about as rugged as a carbon lamp. The lamps when lighted are connected to the remaining 30 cells, 60 volt lamps (instead of 63) being used. This scheme is known as the "Hot-Wire System," and is being patented. Recent figures show lamp lives of from 1,500 to 2,000 hours by this system.

In practice it is found that the two end cells of the battery are no more exhausted than are the remaining cells, as one would at first suppose. This might occur, however, if the burning hours were very short, the lamps being connected most of the time to the two end cells. On account of the lesser current taken from the end cells it is estimated that the lamps should burn an average of about three or four hours out of the 24 to have all the cells exhausted to the same extent.—*From "Train Lighting by Electricity" by Henry Schroeder—Proceedings of the Richmond Railroad Club.*

EFFICIENCY TESTS.—Over 300,000 efficiency tests were held last year by the Pennsylvania Railroad, resulting in the practically perfect record of all employees. The average number of tests each day was 820, and of the total for the year 99.75 per cent. were perfect. Many of the failures, however, were not such as could possibly cause an accident to the train.

HANDLING ENGINES*

H. H. VAUGHAN.

The desirability of pooling engines in place of operating them by regularly assigned crews depends, in the writer's opinion, on whether the engines are engaged in passenger or freight service, and in the latter case, on the conditions which exist.

PASSENGER SERVICE.

Where traffic conditions admit of the engine making greater mileage than can properly be run by one crew, two crews assigned to one engine, or three crews to two engines, will enable the engine to make as great a mileage as is desirable. On account of the comparatively short time occupied from terminal to terminal, the crews can usually make a round trip without holding the engine longer than is required to handle it and prepare it for the return trip or to await its train. By using more than one crew to the engine, it is theoretically available on its return just as soon as though it were pooled. In practice, unless pooling is carried to the extent of sending out any engine on any train, certain engines are regularly used on certain trains or groups of trains, and it is comparatively easy to arrange the crews and engines so that a reasonable time may be allowed for repairs and yet ample service be obtained from the engine. When working with assigned crews it is of course usual to employ some extra passenger men to take the place of the regular men, who are also available in case an extra trip is required from an engine on account of specials or extra sections of regular trains. Where regular scheduled trains have to be provided for, this system is as flexible and convenient as pooling and has the additional advantage in passenger service that the men run certain trains regularly, and will consequently give better service than when handling a number of trains indiscriminately.

Pooling in passenger service probably does not require much discussion. The system is not in extensive use and will presumably have few advocates. The writer would, however, state as a result of his experience with both pooled and assigned engines in passenger service, that he is most strongly opposed to pooling in this service and considers that far better results can be obtained from assigned crews.

FREIGHT SERVICE.

Here conditions are very different. The time is slow and a long time is occupied from terminal to terminal, so that crews may require a full allowance of rest on arrival, or may even have to be relieved on the road. Few, if any, of the trains run at regular hours, and in place of following a defined schedule, the demand for engines varies with the traffic. When business is heavy, engines are wanted as soon as they are repaired and ready for service, making it difficult, if not impossible, to select the engines in any particular order. By pooling, such difficulties may be more easily met, especially at large terminals. When engines are assigned the practice usually required by the agreement with the men is that engines shall be prepared and despatched in the order in which they arrive, but if the engine is ready its use may be retarded by the time required by the crew for rest. In pooling, both these objectionable conditions vanish. An engine may be turned at once if fit for service and thus rendered immediately available, and the movement of the men being entirely independent of that of the engines, the detention of engines at a terminal can be regulated by simply increasing or decreasing the number in the pool.

Under such conditions, if pooling is not carried on in name, it will be in fact, simply because business cannot be handled unless engines are used without reference to the order of their arrival. Granted therefore that pooling is advantageous under these conditions, it should be done properly. All the features necessary to a successful pooling system must be employed, such as thorough terminal inspection independent of the engine crews, and arrangements for handling tools and engine supplies, and caring for headlights, oil cups, etc. If pooling is resorted to when business is especially heavy, or when traffic is disturbed by storms or by other causes, without proper arrangements being made, the results are most objectionable. Under these circumstances, the condition of the power will depreciate rapidly and the service rendered will be excedingly inefficient. The maxim is frequently stated, "If you pool, pool," and its wisdom has been demonstrated by experience. The real question about pooling is therefore whether there are conditions under which it is preferable to adopt the alternative practice, that of running engines with assigned crews. This depends on the results obtained from the two systems, which are in the writer's experience as follows:

Mileage.—It is possible to obtain somewhat greater average mileage per engine under the pooling system, but the increase does not exceed ten per cent. when traffic is being handled smoothly and without excessive congestion and delays.

Repairs.—When running successfully under the assigned engine system, repairs are less than when similar conditions exist with pooled engines. A man running an engine regularly keeps up the smaller details and knows what work is required at once, and what must be looked after in due time. His inspection reports are more reliable than those of a man who has had an engine for one trip only. As he has to run the engine next trip as well, he will handle it with greater care and avoid any action that will cause him trouble in the future. Men who have been accustomed to running pooled engines will not do all this at once, but they most certainly will if assigned to an engine for any length of time, and the difference is noticeable in engine houses where some engines are assigned and some are pooled.

Engines are sometimes taken care of by the headquarters station system, the work required to maintain the engine in proper condition being done at the terminal designated as the home station, while at the other terminal the only work done is that necessary for the return trip. With this arrangement, even with pooled engines, the same crew will, if possible, make the round trip; but when they are changed, practically as much work is required at the away station as at the home station. The result is a considerable increase in the cost of repairs, for there is not as a rule very much difference in the cost at the home station.

When the assigned engine system proves inadequate for traffic demands, the results change. Men will endeavor to book enough work against the engine to hold it until they have rested, and on the other hand engines are liable to be wanted before repairs that are actually required are completed. Under these conditions engines may be better and more cheaply maintained when pooled; but under normal conditions the writer's experience would show that with assigned crews the cost of running repairs may be reduced five to ten per cent. and better mileage obtained from the engines between shoppings.

Fuel.—It is almost impossible to determine the fuel consumed by an engine on an individual trip, and consequently difficult when pooling to keep any record of the amount of coal used by different men. A record may be kept by engines, but it is then impossible to locate the responsibility for any excessive consumption. The practical result is that on pooled engines, individual fuel records are of comparatively little use. With assigned engines, while trip records may not be individually accurate, the average of several consecutive trips soon becomes so, as the variation of the amount of coal left on the tender, while important on one, is of comparatively small importance on a number of trips. There is no doubt in the writer's mind that individual coal records, whether by trip or by period, are an

*Presented before the joint meeting of the A. S. M. E. and I. M. E. at Birmingham, England, July 25, 1910.

important factor in obtaining economical results in fuel consumption, both from men and from engines, and he ascribes the good results that have been obtained on the Canadian Pacific Railway largely to the careful way in which the records have been watched.

Apart from the records, the familiarity of the men with the engines has an important bearing on fuel consumption. Most engines vary slightly in the way they burn the coal, in the nature and intensity of the draft, and in the best position for the throttle and reversing lever. Crews knowing an engine thoroughly learn about these peculiarities, while they do not when running a different engine each trip. One crew will obtain from an engine results that are impossible for another crew, and thus the result with assigned crews is a tendency to higher efficiency than when every engine has to be drafted and adapted to do the work with the poorest crew on the division. It is only necessary to watch the difference in the way an engine is handled by a regular crew and by a pooled crew, to realize the advantage of the former, and important results have been clearly shown with the same men and engines, on divisions where the two systems have been in effect.

Service.—The remarks that have been made in connection with repairs and fuel apply with almost equal force to the class of service obtained from the engines, with reference to failures, breakdowns and ability to make the time required. A crew that knows the engine will get more out of it than one that does not. They will notice any difference in its working and will take more interest in getting any defect rectified. They will keep their equipment in better condition and will pay more attention to bearings which show signs of heating, etc. All these conditions lead to better and more efficient service.

Engine House Expenses.—Inspection, the care of tools, the filling of lubricators, headlights and cab lamps, are commonly looked after on assigned engines by the crews. When engines are pooled this work has to be done by the engine house force. At a large terminal this expense is not large, but when the number of engines handled is small, it is difficult to arrange the duties of the men doing this work to prevent its becoming a serious item. Conditions vary on different roads in this respect, but the fact remains that this work is not in any way burdensome to men having a regular engine, while it is burdensome if they are required to prepare a different engine each trip, and consequently they object to it very strongly. In the majority of cases this work constitutes an additional charge on engines that are pooled.

CONCLUSION.

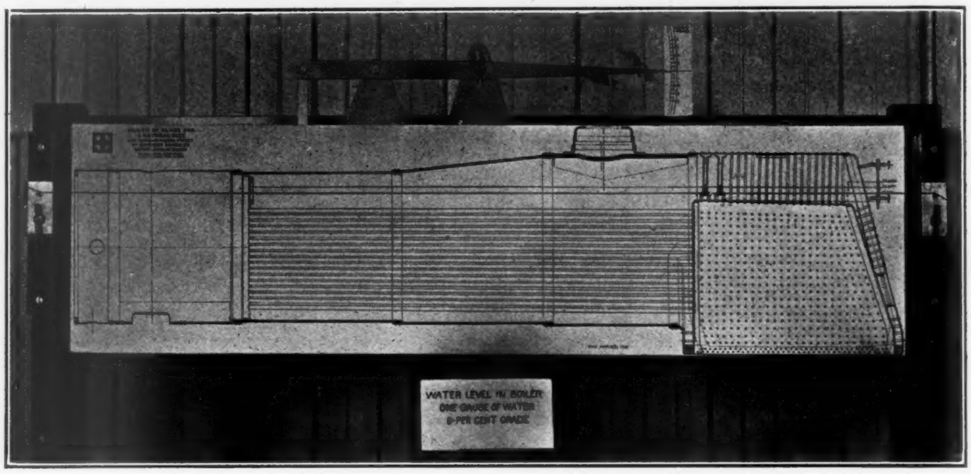
In conclusion, the writer considers that in passenger service pooling is objectionable under any conditions and should be avoided if possible.

In freight service, pooling is advisable if conditions are such that engines cannot be run with assigned crews, and probably on divisions where business is so heavy that sixty engines per day or over are despatched from the terminal; but the writer's experience is that where assigned crews can be used on engines, the cost of repairs, the amount of fuel consumed, and the class of service obtained, will all be more satisfactory.

He therefore regards pooling as a practice that may be necessary under certain conditions, but that is certainly not desirable if the alternative system can be satisfactorily carried out.

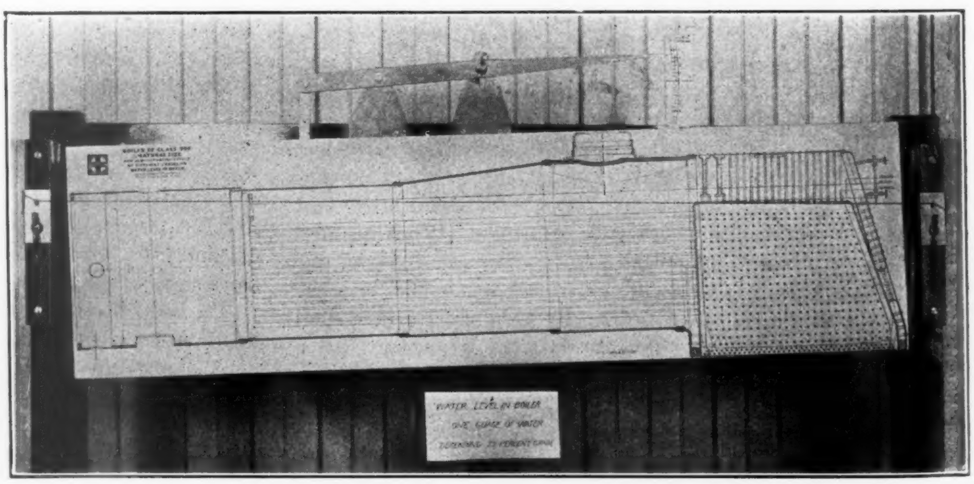
DEMONSTRATING MODEL TO SHOW EFFECT OF GRADES ON WATER LEVEL.

For the purpose of instructing engineers as to the effect on the water level in the boiler of ascending or descending steep grades, a very ingenious model has been originated on the Atchison, Topeka and Santa Fe Railway. These models will be distributed at the various division points where the road foremen will give demonstrations to the engineers, who will also be encouraged to use it themselves whenever they desire.



MODEL SHOWING LOCOMOTIVE ON LEVEL TRACK, ONE GAUGE OF WATER.

The model includes a frame supported at its center of gravity in such a manner that it may be swung to various positions and secured in any desired position. This frame carries a blue print showing the section of a locomotive boiler. Several different frames have been provided, each frame carrying a different boiler, a sufficient number being included to cover the principal classes of locomotives on the system.

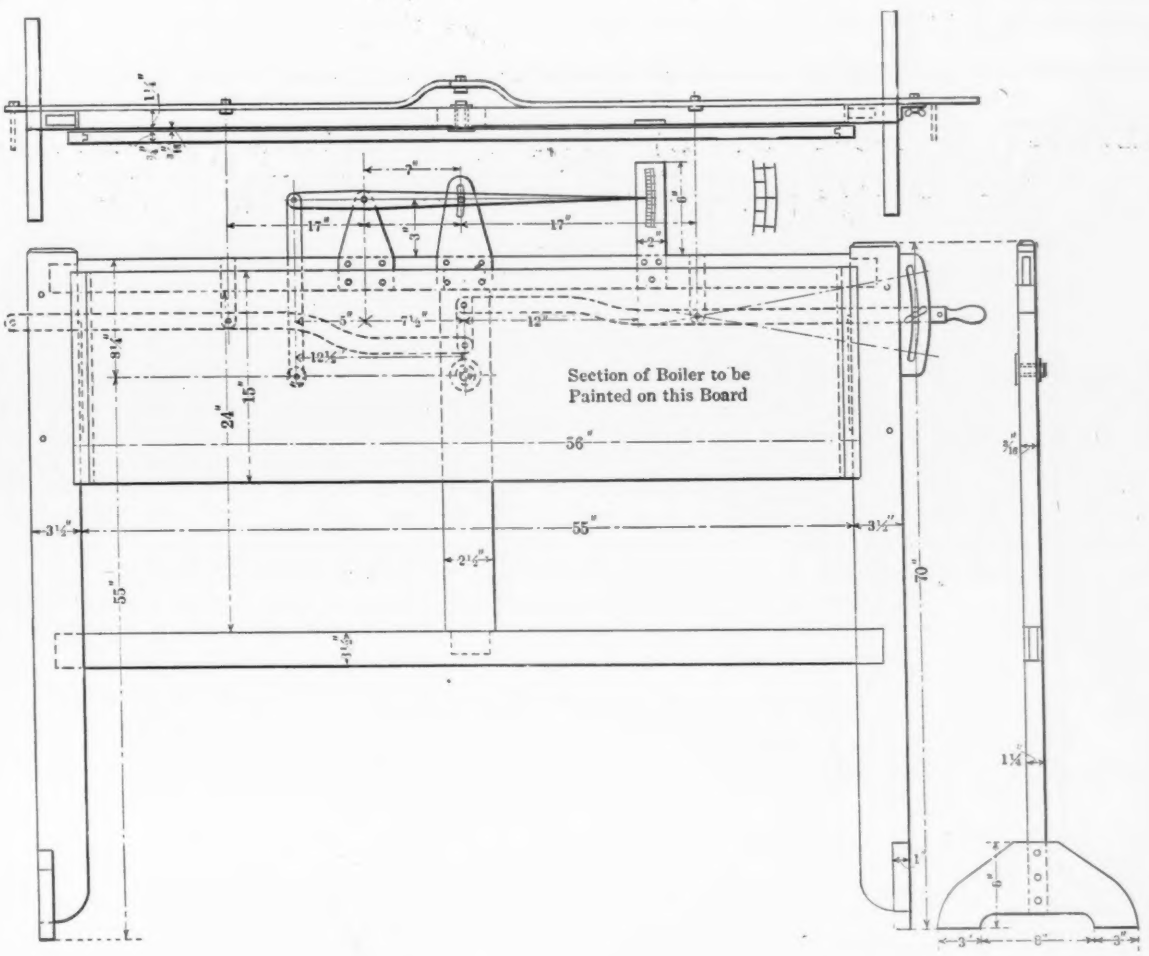


SHOWING EFFECT OF 3.5 PER CENT. GRADE ON THE WATER LEVEL OF A BOILER WITH ONE GAUGE ON THE LEVEL.

Attached to the swinging frame is an indicator arrangement, the pointer traversing a scale which shows the grade that a locomotive would be ascending when the boiler model is adjusted at a certain angle. This is arranged to show a grade from zero to four per cent. Inasmuch as there are a number of heavy grades on several sections of the Santa Fe system, and while 2½ per cent. is by no means uncommon, there are several grades over 3 per cent., and some 3½ per cent., the limit of 4 per cent. shown on the model is not unreasonable.

The frame carrying the blue print, as well as the indicating

mechanism, is supported by a wooden frame that permits it to be moved as desired and locates it at a convenient height. This frame also carries an adjustable mechanism holding a wire representing the water level which stretches across in front of the boiler chart. The mechanism (the photographs show an earlier arrangement) which carries this wire is so constructed that it will be level at all times and permits it to be readily



DETAILS OF MODEL FOR DEMONSTRATING THE EFFECT OF GRADES ON THE WATER LEVEL.

adjusted at any height above the crown sheet or at any gauge of water.

One of the illustrations shows the boiler on a level track, or zero per cent. grade, with one gauge of water in the boiler. On this the depth of water at any point can be readily seen and measured. Another photograph shows the locomotive descending a 3½ per cent. grade and the level of the water which showed one gauge when locomotive was on the level. The bare crown sheet resulting is very strikingly illustrated. The effect when ascending the same grade or of going up or down any grade can, of course, be shown equally well.

This model was originated by W. F. Buck, Superintendent of Motive Power, and the details were designed and the models constructed under the supervision of M. H. Haig, mechanical engineer at Topeka. A patent has been applied for covering the idea and the construction.

COPPER VS. STEEL FOR LOCOMOTIVE FIREBOXES.

In a paper on this subject read by H. B. Lake, chemist to the Western Pacific Railway, before the Western Canada Railway Club, the author stated that sheet copper weighs one-eighth more than sheet steel. Assuming the price of steel at 3 cents and copper at 21 cents, then copper costs seven times as much as steel, and as the thickness of the sheets of copper used in a fire-box is generally about twice that for steel, the initial cost of the material for the copper box will be a maximum of sixteen times that for a steel box. Allowance, however, has to be made for the value of the scrap copper, which locally was stated to be 75 per cent., and allowing 5 per cent. of this for the steel scrap, this reduces the ratio of the cost of the copper plate to about five times that of the steel. As regards the labor cost of making the box, this is in favor of copper. Being the easier metal to work, it induces less wear and tear on tools, and in addition the time required to make the copper box is less. Where cost of labor bears a high ratio to cost of material then this factor will increase in importance.

The possible life of the two fire-boxes depends largely on local conditions. The life of copper boxes on English roads is about ten years, or the equivalent of about 800,000 miles, and copper tube plates last about five years in hard, constant service at high pressure. Steel boxes, under similar conditions, gave a life of only one year, or about 80,000 miles, before requiring repair, and on a certain section of the Canadian Pacific Railway, where the water supplied is of medium quality, the side sheets of steel boxes in new engines required renewal inside twelve months, or after running about 45,000 miles. Hence the labor expended in making steel boxes was as much, or more, than in making copper boxes, and totally, with labor for repairs, it was safe to assume that it was five times as great. Where labor costs as much, or more, than the material used in the box, this reduces the relative cost of the two boxes to about the same figure. This reduces the considerations to the relative time engines fitted with either kind of box would spend in the shops directly consequent to the copper or steel fire-box. Evidently, if a steel box required more frequent repair, the comparison would be in favor of copper.

Another important consideration is the greater reliability of one material by which engine failures, or delays, might b

less than with the other. Copper is more resistant to corrosion than iron, being higher in purity than mild steel, and electrolytic copper, while equally as ductile and tenacious as that produced by smelting and rolling, is even purer.

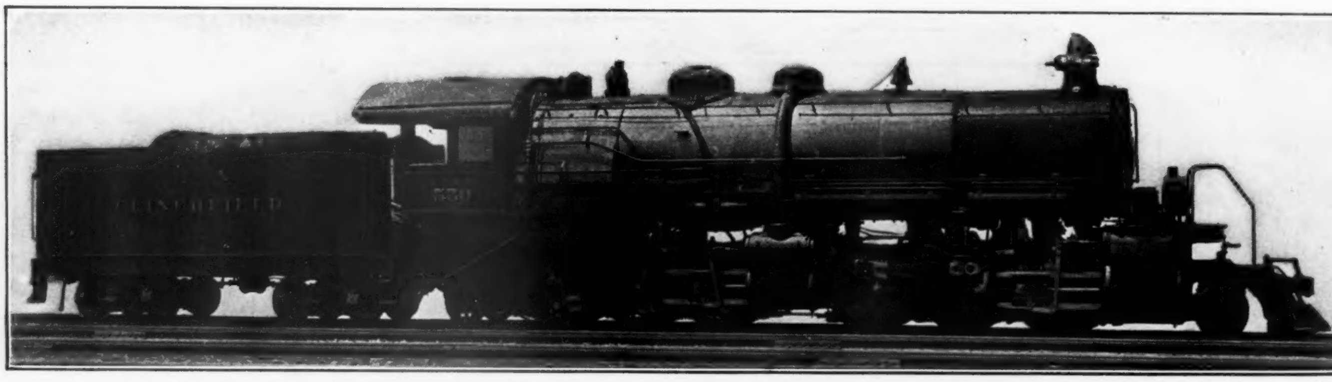
As to tensile strength, copper is almost equal to very mild steel, and in ductility very much higher. It is, therefore, less physically damaged by the punishing operations of riveting and beading than steel, and makes a tighter and more tenacious joint than steel with the tubes or flues.

In conclusion, the author stated that the initial cost of a copper fire-box was much higher than steel. The life cost, allowing for the value recovered on the scrap copper, of copper and steel, was about equal. Copper sustains mechanical work better, and makes stronger and tighter joints than steel. It takes up sudden fluctuations in temperature more quickly and uniformly. Copper offers greater resistance to corrosion than steel. Therefore, engines fitted with copper fire-boxes should spend less time in shop directly consequent to fire-box trouble, and be less liable to failure on the road from leaking of stays and tubes and cracking of plates.

FREIGHT (2-6-6-2 TYPE) AND PASSENGER (4-6-2 TYPE) LOCOMOTIVES FOR A LOW GRADE LINE

CAROLINA, CLINCHFIELD AND OHIO RAILWAY.

Running almost directly north and south from Elkhorn City, Ky., to Spartanburg, S. C., and passing through sections of three other states, the Carolina, Clinchfield and Ohio Railway has been constructed largely for handling coal from the West Virginia fields. The line is built in the most modern manner throughout, with no hesitating at expensive cuts and tunnels or extensive trestle work to obtain the straightest line with a minimum grade. The result is that, opposed to loaded traffic, the maximum grade is but one-half of one per cent. and the sharpest curve on the line is 8 degs.

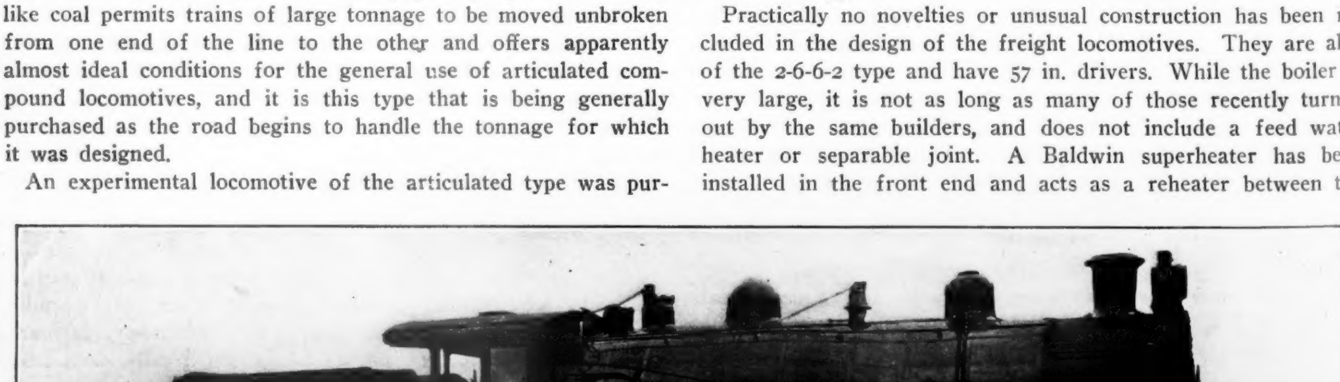


POWERFUL FREIGHT LOCOMOTIVE BUILT AT BALDWIN'S FOR THE CAROLINA, CLINCHFIELD AND OHIO RY.

A road of this character handling principally a commodity like coal permits trains of large tonnage to be moved unbroken from one end of the line to the other and offers apparently almost ideal conditions for the general use of articulated compound locomotives, and it is this type that is being generally purchased as the road begins to handle the tonnage for which it was designed.

An experimental locomotive of the articulated type was purchased last year from the Baldwin Locomotive Works in order to determine accurately the possibilities of the Mallet under the local conditions. That locomotive weighs 342,000 lbs., of which 330,000 lbs. is on driving wheels, it being of the 2-6-6-2 type. It has been found that it will very comfortably handle a train of 4,000 tons, and the result of its service has been so satisfactory that the road is now receiving from the same builders 10 more Mallet compounds, which, while not excessively large, are somewhat more powerful than the experimental engine. In the same order were also included three passenger locomotives of the Pacific type.

Practically no novelties or unusual construction has been included in the design of the freight locomotives. They are also of the 2-6-6-2 type and have 57 in. drivers. While the boiler is very large, it is not as long as many of those recently turned out by the same builders, and does not include a feed water heater or separable joint. A Baldwin superheater has been installed in the front end and acts as a reheater between the

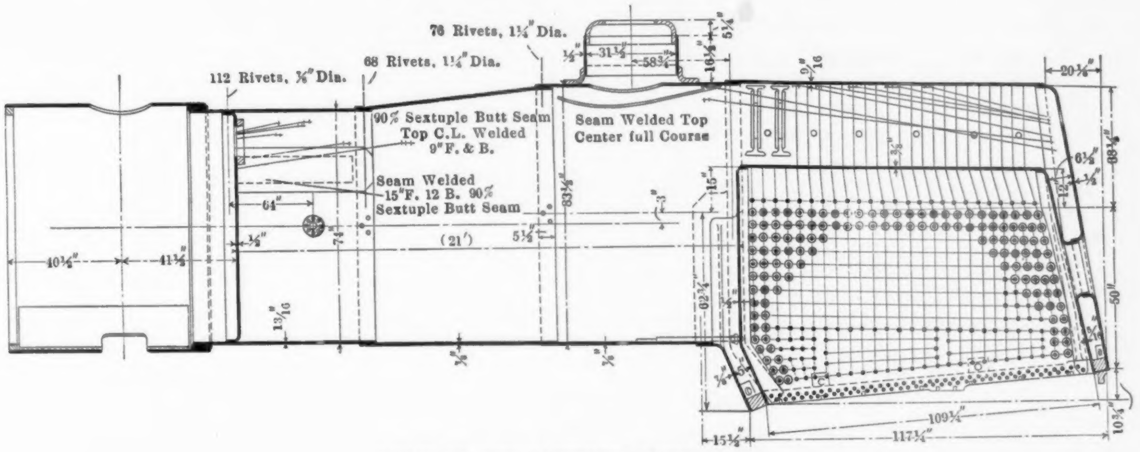


THREE PASSENGER LOCOMOTIVES OF EXCEPTIONAL CAPACITY WERE ALSO BUILT.

high and low pressure cylinders. An examination of the ratios shows the steam making capacity to be ample and the proportion of the grate area to heating surface to be well suited for a first class grade of coal, such as will be available in this district.

In general the design follows very closely what might be called standard practice, if it be conceded that the Mallets have reached a standard. The boiler is equipped with a radial stay firebox, which has 404 flexible staybolts grouped in the outside rows on the sides and back, and in the upper corners of the sides. Flexible stays are also used in the triangular areas in either side of diameter. Those on the high pressure cylinders have inside admission, while the low pressure have outside admission. A flat plate type of relief valve is applied to the top of the steam chest in a manner customarily used by these builders. The valve gears are controlled by a Ragonett power reversing gear, the reach rod between the high and low pressure reversing shaft being carried along the center line of the locomotive, with a universal joint at the high pressure cylinders.

The frames are of cast steel 5 in. in width and the arrangement and construction is the same as customarily used by the



BOILER OF THE PASSENGER LOCOMOTIVES.

the throat sheet. The dome is placed on the center of the three rings of the barrel, and is directly above the high pressure cylinders; 448 2¼ in. flues, 21 ft. in length in an 86 in. diameter shell permits a very liberal width of bridges and satisfactory general arrangement. This gives a heating surface in the tubes of 5,519 sq. ft., the total heating surface being 5,752 sq. ft. or 73.8 sq. ft. per square foot of grate area.

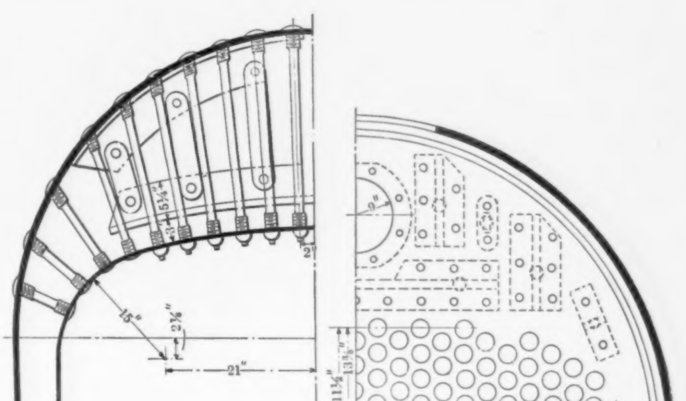
The boiler is supported on the rear frames by means of a plate at the back end of the mud ring and sliding bearings on the front in the usual manner. It is also supported at the high pressure cylinders, the distance from the center of the cylinders to the face of the throat sheet being 10 ft. 4⅝ in. There is further a plate support at the high pressure guide yoke, which is about 28 in. ahead of the throat sheet. On the front frames there is but one actual support, which is located midway between the second and third drivers and 92 in. ahead of the joint, which is in the builder's customary location on the center line of the high pressure cylinders. This sliding bearing is arranged in the usual manner with a renewable friction plate, its surface being 19 in. above the top of the frames. The centering springs for the front group are located midway between the first and second drivers of this group, 64 in. ahead of the bearing plate. This point, while normally clearing one-half inch, can take a bearing in case of necessity and relieve the main bearer to some extent.

High pressure steam is carried from the dome to the top of the high pressure valve chest through outside pipes in the customary manner. The exhaust from these cylinders is led forward through two pipes along the outside of the boiler to the connection with the reheater in the front end, the arrangement being similar to that used on the Southern Pacific locomotive (see AMERICAN ENGINEER, May, 1909, page 181). From the reheater it passes downward through a pipe having two ball and a sliding joint to a passage in the frame casting on which the low pressure cylinders are supported. From here it goes to the cylinders through two short elbow pipes. The exhaust opening from these cylinders is just above the steam inlet and elbow pipes carry it forward ahead of the cylinders, where they unite into a T shape casting and the return is made through a flexible connection to the exhaust nozzle. The carrying forward of the exhaust line in front of the cylinders was made necessary by the very short distance between the center of the low pressure cylinders and the exhaust pipe—about 44 in. Piston valves are used throughout, they being of duplicate design 15 in. in

builders for this type of locomotive, which has been illustrated very thoroughly in these pages.

PASSENGER LOCOMOTIVES.

Three very powerful Pacific type locomotives comprise the order for passenger engines, being delivered with the freight engines. These locomotives have a theoretical tractive effort of



SECTIONS OF BOILER.

37,000 lbs., which is unusually large for a passenger locomotive and is obtained by the use of 69 in. wheels and a 30 in. stroke. A large theoretical tractive effort on a passenger locomotive, or in fact on any locomotive, is meaningless unless it is backed up by sufficient boiler capacity to make it available at other than

very low speeds. This feature in this case is well taken care of not so much by the actual amount of heating surface as it is by the large size of the boiler and the liberal spacing of the flues. The B. D. factor of 625 and a ratio of heating surface to cylinder volume of 283 do not clearly indicate the probable steam making capacity of the boiler. When it is considered that this boiler is 74 in. in diameter at the front end, is of the extended wagon top type, and measures 83½ in. at the connection to the fire box, and that it contains 317 2¼ in. tubes, 21 ft. in length, it is evident that with a good grade of fuel it will be possible to make and free all the steam necessary and that the steam storage space is sufficient to furnish a reasonable dry supply for the cylinders. The fire box is somewhat similar to the Mallet locomotives, although it has not as wide a grate. The side sheets are practically vertical and there are 386 flexible stays distributed on the back head and side and throat sheets. The Master Mechanic style of front end is used with a long inside extension of the stack and an adjustable diaphragm plate in front of the nozzle. It is self clearing and no cinder hopper is provided.

Cast steel main frame 5 in. in width extend from in front of the forward pedestal to the tail casting, the trailing frames being integral with them. The front frames are of forged iron, being single on each side and hooked and double keyed into the main frame, being secured by 4 1½-in. vertical bolts. At the point of connection to the cylinders the frame has a section of 4½ x 7 in.

A radial type trailing truck with outside journals and remarkably simple design has been employed. The journal box was secured to the radial frame and the swing motion is allowed by the movement of the spring links, which are set on flat keys at each end arranged to permit free side motion and a limited amount of fore and aft motion. A semi-elliptical spring rests on top of the box and is carried in a cast steel frame to which the spring links are connected. The whole construction offering practically no resistance to the side motion of the truck. The spring and its frame work are held in place by an extension from the sides of the journal box.

Fifteen inch piston valves of the same design as were used on the Mallet locomotives are here employed. The valve chambers are set inside and 18½ in. above the cylinder centers, which permits a very satisfactory and direct arrangement of the steam and exhaust passages. This location of the valve chamber necessitates the use of a rocker arm in the gear, which is carried from an extension on the guide yoke and connects to the valve stem through a cross head connection, the stem being guided at the back end. The valve gear is straight forward in design, the link being supported by the usual longitudinal bearers outside of the driving wheels. The center of the link is placed 23½ in. above the center of the axle, the cylinder centers being 1½ in. above the axle. The link from the reversing shaft connects to the radius bar at a point 16 in. in front of the block.

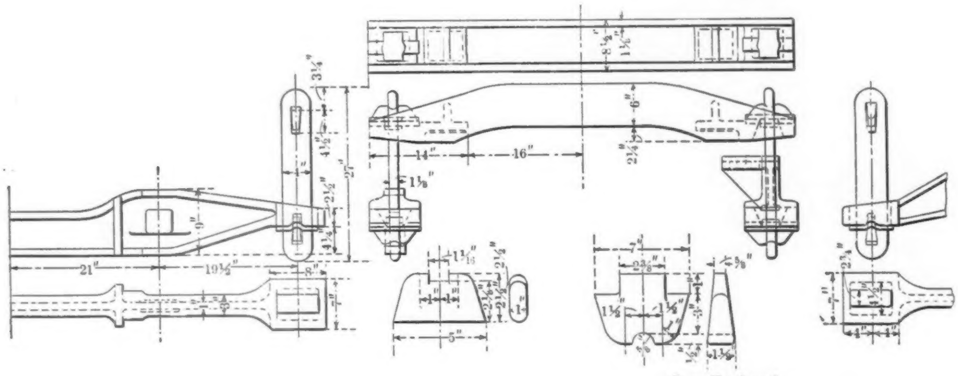
Twelve inch channels make up the sills of the tender frame, the center sills weighing 40 lbs. per ft. and the side sills 25 lbs. The tenders for both the freight and passenger engines are similar in design, the former, however, being of somewhat larger capacity. The trucks for both are of the arch bar type, the passenger engines having steel tired wheels, while the freight tenders have been fitted with solid rolled steel wheels. The freight engines have a 10,000 gallon tank and a capacity for 15 tons of coal, while the passenger engines have an 8,000 gallon capacity tank and 14 tons of coal.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.		
Type	2-6-6-2	4-6-2
Fuel	Bit. Coal	Bit. Coal
Tractive effort	77,500* lbs.	37,000 lbs.
Weight in working order	378,650 lbs.	233,050 lbs.
Weight on drivers	325,850 lbs.	152,900 lbs.
Weight on leading truck	24,600 lbs.	42,750 lbs.
Weight on trailing truck	28,200 lbs.	37,400 lbs.
Weight of engine and tender in working order	550,000 lbs.	385,000 lbs.
Wheel base, driving	31 ft.	13 ft.
Wheel base, total	46 ft. 6 in.	34 ft.
Wheel base, engine and tender	74 ft. 11 in.	65 ft. 10 in.
RATIOS.		
Weight on drivers ÷ tractive effort	4.22	4.13
Total weight ÷ tractive effort	4.88	6.30
Tractive effort x diam. drivers ÷ heating surface	767.00	625.00
Total heating surface ÷ grate area	73.80	75.80
Firebox heating surface ÷ total heating surface, %	4.06	4.70
Weight on drivers ÷ total heating surface	56.80	[illegible]
Total weight ÷ total heating surface	65.80	57.00
Volume equiv. simple cylinders, cu. ft	23.70	14.40
Total heating surface ÷ vol. cylinders	242.50	283.00
Grate area ÷ vol. cylinders	3.29	3.74
CYLINDERS.		
Kind	Compound	Simple
Diameter	24 & 37 in.	23 in.
Stroke	32 in.	30 in.
VALVES.		
Kind	Piston	Piston
Diameter	15 in.	15 in.
Outside lap	1⅛ in.	—
Inside clearance	¼ in.	—
Lead	¼ in.	¼ in.
WHEELS.		
Driving, diameter over tires	57 in.	69 in
Driving, thickness of tire	3½ in.	3½ in.
Driving journals, main, diameter and length	11 x 13 in.	10 x 13 in.
Driving journals, others, diameter and length	10 x 13 in.	9 x 13 in.
Engine track wheels, diameter	33 in.	33 in.
Engine truck, journals	6½ x 12 in.	6½ x 12 in.
Trailing truck wheels, diameter	33 in.	45 in.
Trailing truck, journals	6½ x 12 in.	8 x 14 in.
BOILER.		
Style	Straight	W. T.
Working pressure	200 lbs.	190 lbs.
Outside diameter of first ring	86 in.	74 in.
Firebox, length and width	117 x 96 in.	108⅛ x 71¾ in.
Firebox plate, thickness	⅜ & ½ in.	⅜-5/16-½ in.
Firebox, water space	F 6, S. & B, 5 in.	F. 5, S. & B., 4 in.
Tubes, number and outside diameter	448—2¼ in.	317—2¼ in.
Tubes, length	21 ft.	21 ft.
Heating surface, tubes	5,519 sq. ft.	3,903 sq. ft.
Heating surface, firebox	233 sq. ft.	192 sq. ft.
Heating surface, total	5,752 sq. ft.	4,095 sq. ft.
Grate area	78 sq. ft.	54 sq. ft.
Center of boiler above rail	122 in.	112 in.
TENDER.		
Tank	Water bottom	Water bottom
Frame	12 in. chan.	12 in. chan.
Wheels, diameter	33 in.	36 in.
Journals, diameter and length	6 x 11 in.	5½ x 10 in.
Water capacity	10,000 gals.	8,000 gal.
Coal capacity	15 tons	14 tons

$$^{*}\ \frac{1.2\,P\,d^2\,s}{D} = T.\,E.$$

d = Diam. H. P. cylinder.



EQUALIZERS AND SPRING HANGERS AT TRAILER TRUCK OF 4-6-A TYPE LOCOMOTIVE.

During 1909 a total of 177,802 trains were dispatched from Grand Central terminal, New York, averaging one train every three minutes for the whole twenty-four hours. The delay in dispatching aggregated 36,563 minutes, an average detention of twelve seconds per train. The total length of these trains, placed end to end, would be 14,143 miles.

A NEW LOCOMOTIVE SUPERHEATER.

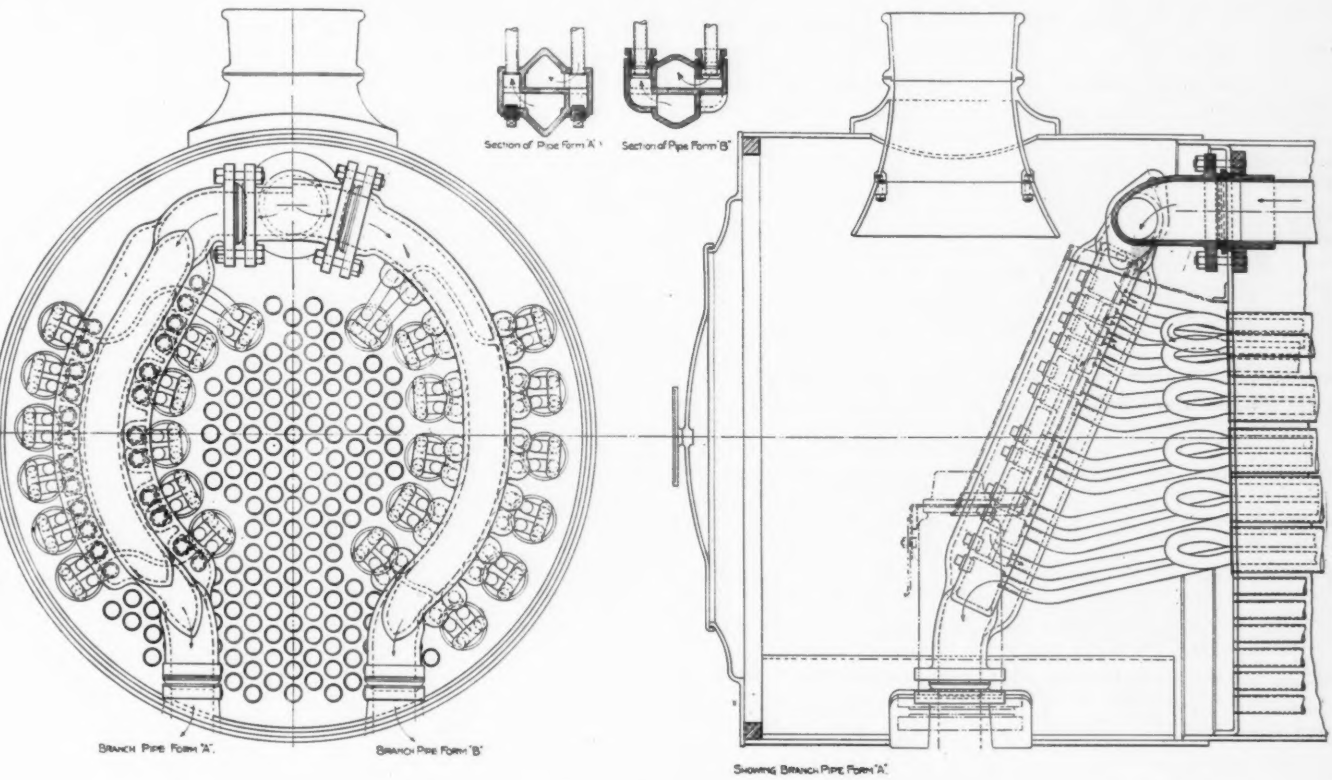
An interesting development of high degree locomotive superheater is shown in the accompanying illustration. This arrangement incorporates a double looped unit enclosed in a large boiler tube in the same manner as other fire tube superheaters. The chief difference in the arrangement in this case is in the headers, which have much the same appearance as the ordinary steam pipes at the front end, using the same arrangement of ball connections to the T head and cylinders. Each of these headers is separated by interior walls into two chambers, connection between each is only obtained through the medium of the superheater pipes.

Two designs of headers are shown; the one marked "A" has its tube connection bosses and ports formed within the pipe and the tubes are expanded into the bosses. In the form marked "B" the tube connection is formed outside of the header, the tube ends being expanded into collars, which have a ball joint seat on the header and are secured by a locking block. This block is constructed to take care of all uneven expansion.

In the event of a mishap to the coil with the form "A" header it is necessary to remove the front plug and cut the coils with the tube cutter. Then the element can simply be revolved and drawn out of its large tube without disturbing any other part of the superheater. In the form "B" it is simply necessary to release the collar connection to the header and revolve the element in the same manner as above. It is easily and quickly removed. The most noticeable advantage of this arrangement is the comparatively small obstruction in the front end that permits convenient attention and repair to the regular boiler tubes and also the possibility of using the regular front end arrangement of diaphragms and nettings.

In general this design is similar to the Emerson superheater that is now being applied to quite a large number of locomotives (See AMERICAN ENGINEER, February, 1910, page 65). It has an advantage over that arrangement, as used on the Great Western locomotives, in convenience for removing the superheater elements and giving more room in the front end for removing boiler tubes.

This design has been patented by Willis L. Riley, of St. Paul.



HIGH DEGREE LOCOMOTIVE SUPERHEATER OF SIMPLE DESIGN.

ELECTRIFICATION OF THE SALT LAKE & OGDEN RY.

The electrification of the Salt Lake & Ogden Ry. has been completed. The service at present will consist of a train every 45 minutes out of Salt Lake City, Utah, for Lagoon after 2 P. M. every day, and a through train out of Salt Lake City for Ogden and intermediate points beginning at 6:10 in the morning and continuing until 11:45 at night. It will require only 30 minutes to make the run between Salt Lake City and Ogden. The cars will be operated in trains under multiple unit control.

For the present, trains will be run to the old station on West Third street, but as soon as possible a station will be constructed on Richards street, and the cars brought to that place. A new station has been built in Ogden at the corner of Lincoln avenue and Twenty-fifth street, a block east of the union depot. The cars are of special design, 56 ft. long, and weigh 38 tons. A new power plant is now under course of construction at Lagoon, and will be completed within the next six months. Until that time power will be furnished by the Telluride Light & Power Co.

All freight will be transported at night. It is proposed to keep the line free from all construction trains until the end of the busy season, when the double tracking will be completed. A block system is being installed and at all danger points already is ready for use. For the present, freight trains will be hauled by steam locomotives and later by electric locomotives.

MOTOR CONTROL AND MACHINE OUTPUT.—The output of a machine tool motor depends, to a considerable degree, upon the convenient arrangement of the control and the importance of the arrangement from the standpoint of the operator cannot be ignored, since the output of a tool will be materially increased when an operator can start and stop the tool and obtain at all times maximum cutting speeds by simply turning a handle. The controller must be placed in a safe position and should be accessible for repairs, which very often means that some arrangement is necessary to bring the operating handle within easy access of the operator, as for instance the arrangement commonly seen on lathes where the operating handle travels with the tool carriage.—*Chas. Fair before A. S. M. E. and A. I. E. E.*